ON VARICOCELE

WILLIAM H. BENNETT

VARICOCELE

By the same Author.

With Three Plates, 8vo. price 6*s*.

CLINICAL LECTURES ON VARICOSE VEINS OF THE LOWER EXTREMITIES.

London: LONGMANS, GREEN, & CO.

ON

VARICOCELE

A PRACTICAL TREATISE

BY

WILLIAM H. BENNETT, F.R.C.S.

SURGEON TO ST. GEORGE'S HOSPITAL, MEMBER OF THE BOARD OF EXAMINERS ROYAL COLLEGE OF SURGEONS OF ENGLAND, LECTURER ON CLINICAL SURGERY AND ON ANATOMY IN ST. GEORGE'S HOSPITAL MEDICAL SCHOOL

WITH FOUR TABLES AND A DIAGRAM

LONDON

LONGMANS, GREEN, AND CO.

AND NEW YORK: 15 EAST 16th STREET

1891

PRINTED BY
SPOTTISWOODE AND CO., NEW-STREET SQUARE
LONDON

PREFACE

The following monograph is offered as a further contribution to the literature of Varicose Veins.

The conclusions are the outcome of the careful study of (1) about 250 cases of varicocele seen in hospital and private practice; and (2) a large number of dissections and *post-mortem* examinations.

In attempting to deal comprehensively with a subject so familiar, it is obvious that reference must be made to many matters of common knowledge. At the same time there are, I venture to think, several questions connected with varicocele which have not yet been entirely exhausted, and it is to them that I more especially wish to call attention.

W. H. B.

Chesterfield Street, Mayfair:
May 1891.

CONTENTS

PART I

GENERAL CONSIDERATIONS

PART II

TREATMENT

TABLES

DIAGRAM

VARICOCELE

PART I

GENERAL CONSIDERATIONS

Definition

For clinical purposes the term Varicocele should be restricted to *a well-marked general swelling, or distinctly defined tumour about the spermatic cord*, due to varicosity of the spermatic veins originating in defects or abnormalities in the venous apparatus, which are often hereditary and always congenital. In the majority of cases there co-exists more or less defective development of the corresponding testis, which may in some instances be sufficient to cause serious functional imperfection in the organ.

The restriction of the term to distinctly marked cases is essential, mainly on two grounds: 1st, almost all individuals show some slight fulness of the spermatic veins on the left side as compared with the right; 2nd, slight enlargements, with or

without noticeable tortuosity, of these veins of a temporary or permanent nature occur in many perfectly normal subjects from the effects of increased intra-abdominal pressure, &c.

If, therefore, the term were used in its most comprehensive sense a clinical absurdity would result, since such a very large proportion of healthy men would have to be classed as sufferers from varicocele.

Frequency of Occurrence

Taking into consideration all classes of subjects, it may safely be said that not more than 5 or 6 per cent. have sufficient enlargement of the spermatic veins to justify the term varicocele.

This percentage is less than that noted by some previous observers, the difference being apparently due to the fact, already mentioned, that I confine the term to well-marked cases.

The percentage of subjects presenting slight temporary or permanent fulness or tortuosity is much greater. With reference to this point, it is especially important to remember that the fact of the veins on the left side being merely larger than those on the right, although the difference may be considerable, does not necessarily indicate the existence of varicocele, since the veins on the two sides are so frequently unequal in size.

Of subjects affected with varicocele, properly so called, nearly 50 per cent. are unaware of its existence until it has been pointed out to them or has been discovered accidentally. Only 20 per cent. of the gross number of varicoceles give rise to any noticeable symptoms, and of the cases known to the patients treatment is sought in 25 per cent., approximately. This last percentage may be raised to something like 45 by persons applying for operation, in consequence of rejection or prospect of rejection for the public services.

The number of cases coming under observation in feeble and lymphatic subjects is much greater than in the strong and robust (excluding those who apply for advice from curiosity, or in connection with the requirements of the public services), although the tendency to the affection, as shown by slight abnormal fulness of the veins, appears to be about equal in the two classes.

The actual excess of these cases in the feeble and lymphatic is 45 per cent. or thereabouts, but it is necessary to note that the feeble and nervous class of subjects seek treatment for much slighter reasons than the robust. Hence the mere excess in the number of cases causing symptoms in this class is really no evidence of the actual existence of a greater number of varicoceles, as such, in men of this kind.

With a view to ascertaining, as accurately as was practicable, the exact proportion of varicoceles occurring in the two classes of subjects referred to, I examined (1) a series of three hundred robust patients admitted into St. George's Hospital for injuries or unimportant surgical diseases, e.g. fractures, innocent tumours, &c.; and (2) a series of three hundred patients who were feeble, or naturally lymphatic, admitted for reasons similar to those just mentioned, and not exhausted by organic disease or long continued illness. The result will be seen in the following table which, of course, does not in-

TABLE I

Showing the number of cases of varicocele found in a series of 600 *healthy subjects examined: a, robust; b, feeble or lymphatic.*

—	Total number of subjects examined	Cases in which slight abnormal fulness of the spermatic veins existed on one or both sides	Cases in which the veins were sufficiently large to constitute varicocele	Cases in which the patients were aware of the existence of varicocele	Cases in which the varicocele had caused any noticeable symptom	Cases in which treatment had been sought
(*a*) Robust . . .	300	36	15	5	2	0
(*b*) Lymphatic, or feeble .	300	40	28	18	8	5
Total cases in the two classes . . .	600	76	43	23	10	5

The small excess in the number of cases of slightly abnormal fulness of the veins found in the feeble and lymphatic subjects, is probably accounted for by the fact that in them the flabbiness of the scrotum allowed the vessels to be more easily felt, and does not, therefore, necessarily indicate any actual preponderance of full veins in this class of subject.

clude any patient admitted for varicocele or other affection of the genito-urinary system.

As to the relative frequency of occurrence on the two sides, I find that in 100 consecutive cases examined, the varicocele involved the left side only in 80, the right side only in 1, and both sides in the remaining 19.

It would seem, therefore, that instances in which the right side is alone affected are so rare as to be hardly worth consideration, excepting as curiosities. I have seen two other cases limited to the right side, but my experience in this respect appears to be exceptional so far as recorded cases are concerned, for Breschet, who early in the present century probably had as large an experience of varicocele as any one of his own time or since, never saw an example in which the right side was alone affected. In the more recent literature of the subject, again, although mention is made of possible limitation to the right side, no record is made of cases actually seen.

The causes of this remarkable discrepancy in the number of cases occurring on the right and left side will be fully considered subsequently.

Symptoms

These may be conveniently considered under three heads: (A) Objective, (B) Subjective, and (C) Complicating.

Objective Symptoms

A well-defined tumour lying along the course of the spermatic cord, softish and compressible (not reducible), presenting, as a rule, a distinct impulse on coughing, disappearing or greatly diminishing when the patient lies down, and reappearing (filling) from below when the erect position is assumed, in spite of firm pressure over the abdominal ring.

When handled the swelling affords the characteristic sensation traditionally likened to the feel of a bag of earthworms, a description rendered still more apt by the *peculiar writhing movement which is imparted to the emptying veins by the cremaster muscle* immediately upon the recumbent position being assumed.

The scrotum is usually flabby and over-dependent; tortuous veins may or may not be seen coursing in its walls. The size of the tumour increases with warmth, contracts with cold, and is usually larger after fatigue or exhaustion.

To the following points I am unable to find any precise reference either in the ordinary works of surgery or special treatises on the subject.

The tumours met with in varicocele present themselves in three distinct varieties:—

1. An elongated diffused swelling extending from

the external abdominal ring down to the testicle, where it is, as a rule, somewhat larger than higher up. The veins to the touch appear to be large throughout, and at the lower part so surround the testicle that its outline is often entirely lost.

2. A large globular swelling massed around the testicle and extending about half-way up to the external abdominal ring; from its upper end full veins run, but the swelling caused by them is altogether unimportant as compared with that about the testis, and that forming the upper part of the tumour just described.

3. A well-defined rounded tumour close to the abdominal ring, extending about half the way down to the testicle; running into the lower end of the tumour, veins not much larger, but altogether more resistent than normal, may be felt. The testicle lies at the bottom of the scrotum, and may or may not be surrounded by a cushion of small veins so closely connected with the organ as to easily escape notice, or be mistaken, by the patient, for evidence of an unusually well-developed testicle.

These several forms of tumour are, I believe, not different stages of the same condition, but depend, originally at all events, upon perfectly distinct conditions which have an important relation to the probabilities of growth of the disease on the one hand and its treatment on the other.

Class 1 is the commonest form met with in cases which have been noted from childhood; of the three varieties it is the least likely either to grow or to give rise to serious symptoms.

Class 2 is very commonly looked upon by patients as an unusually large testicle; growth of the varicocele is liable to occur especially about the time of puberty, and also at later periods.

Class 3, the rarest form of tumour met with, is seen only in robust subjects, and generally declares itself suddenly during great exertion. Its rounded nature and its situation render it more liable to be mistaken for hernia than either of the other varieties, a mistake the more probable, as the tumour, when small, can be pushed up into the inguinal canal, and may again be rendered prominent by coughing. In course of time this variety conforms to some extent to the type of Class 1, but the veins in its upper part remain relatively large throughout the progress of the affection.

Some further points connected with the origin of these varieties of tumour will be found in the section dealing with the condition of the veins.

Subjective Symptoms

These may occur in connection with increase in the size of the varicocele, or quite independently of

any such change, and include sensations of weight, dragging, or tension, pain and tenderness.

1. *Sensations of weight, dragging, or tension.*—These symptoms are not the most commonly seen, as would naturally be expected, in the largest varicoceles, but rather in those of moderate size which have at some time undergone rapid or steady enlargement. They increase in severity as the day advances, and after long standing, especially if the parts be unsupported by a suspender or something of the kind. The degree of discomfort is, as a rule, in direct ratio to the fulness of the veins; hence it is increased by exhaustion or warmth, or any other circumstances which may lead to general relaxation of tissue, and is consequently much more felt by the feeble or lymphatic than the robust. The excessive fulness of the veins may be due to active causes, i.e. obstruction from above to the circulation, or may be merely passive from the gravitation of blood in veins unusually long in themselves, or over-dependent, in consequence of the modification or withdrawal of the support, normally received from the parts immediately around; *cæteris paribus*, the discomfort is greater in the former of these conditions.

2. *Pain.*—This varies in character, may be dull and aching, acute, crampy, persistent, or intermittent, in each of these cases affecting the varicocele itself; or neuralgic, in which case it is usually referred to

the testicle, sometimes also shooting down the inner side of the thigh and radiating over the inguinal region.

The dull, aching form of pain is merely an exaggeration of the weight and dragging previously described. The conditions producing it are, as a rule, the same, and it is affected by the same circumstances. The only pain characteristic of, and peculiar to varicocele, as compared with other varicose diseases, is the intermittent, crampy kind. This is most commonly seen in robust subjects, especially those in whom the affection is of the type represented by tumour, Class 3; it may, however, occur in any case in which the disease is increasing.

The explanation of this symptom is interesting, and I can find no published reference to it.

So far as I am able to judge, this kind of pain is determined by the condition of the cremaster muscle; indeed, the slighter variety of it is, I believe, merely due to cramp in that muscle, set up by the irritation produced in the structure by its efforts at sustaining the varying weight of a large varicocele. This belief receives corroboration from the fact that the discomfort can be almost immediately relieved by pinching the cord between the fingers. It is also the only symptom connected with the affection which is relieved by the pressure of a truss, and it is entirely obviated by the use of a proper suspender.

To fully appreciate the way in which the cremaster acts in this connection, it is necessary to understand its normal purpose.

The cremaster is the natural suspender of the testicle; in this it is aided in a very slight and secondary degree by the contractile tissue of the scrotum, a point to which further reference will be made. With every effort of the body causing tension of the abdominal muscles, the cremaster contracts and raises the testicle. It is clear that the power of the cremaster, in common with other muscles, must be limited. In the case of varicocele, this limit is reached when the disease increases to a size which is too heavy for the muscle to raise. Hence, this crampy pain, although present in some cases during this growth, ceases altogether, or is supplanted by the dull aching variety when the weight is sufficient to overpower the cremaster altogether, although even then it may for a time be felt in the mornings after the patient rises, in consequence of feeble attempts of the muscle to assert its power.

The very acute intermittent and sharp pain felt by some robust subjects (particularly in cases of tumour, Class 3) during exertion, is partly due to the sudden tension in the veins, causing them to be compressed by the margins of the inguinal canal, but is more especially caused by the cremaster muscle,

which in its contraction suddenly, as it were, forces the full veins against the sharp edges of the external abdominal ring.

3. *Tenderness.*—This may occur with or without pain. When pain is present it may be dull or acute, persistent, or intermittent.

Tenderness with pain is usually due to repeated slight injuries, such as may be produced by the friction or jolting in riding, to over-sensitiveness the result of sexual irritation or exhaustion, and to the formation of acute thrombus. The two symptoms are also generally combined in the neuralgic pain in or about the testicle, which is particularly prone to occur in those who have been long resident in hot climates.

Tenderness, without pain other than that which is produced upon pressure, may be caused by passive or organised thrombus, by phleboliths, and is frequently present in the testicular portion of large varicoceles, its source not being apparent; it also occurs, as a transient symptom, during the rapid increase in size which is seen in some cases about the time of puberty.

In patients who are over-anxious about their complaint, tenderness is apt to result from the constant manipulation to which the varicocele is subjected, a point worth bearing in mind when such persons apply for treatment.

Complications

1. *From injury.*—Slight injuries may cause pain and tenderness merely of a transitory nature. Injuries (e.g. sharp blows) of a more severe kind may be followed by inflammation and thrombus. Occasionally a large blood tumour follows upon injury, in consequence of the actual rupture or laceration of one of the veins; the probability of such a lesion occurring will depend partly upon the violence of the injury, and partly upon the condition of the veins, which, if full and tense, are naturally more liable to rupture than when comparatively empty or flaccid. It has been stated that a hæmatocele may be thus caused, but the bleeding is much more likely to take place into the cellular tissue around the veins than into the tunica vaginalis. The largest blood extravasation I have ever seen in the scrotum was due to a blow on a varicocele from a cricket-ball.

2. *Spontaneous rupture.*—This is very rare. I was, however, fortunate enough several years ago to see a case in an old man whose varicocele undoubtedly burst whilst he was straining at stool, a large blood extravasation being the result. No harm followed, the blood was gradually absorbed, leaving a considerable portion of the veins completely blocked.

3. *Thrombus.*—This may be due to injury or to extension of inflammation from neighbouring parts,

as, for instance, in cases of epididymitis of gonorrhœal origin. In either of these cases there is much pain and tenderness. Thrombus of a perfectly passive kind occurs in gouty subjects, in persons who have been long resident in hot climates, and in those who are the subjects of heart disease or very feeble circulation.

Evidence of ancient thrombus, in the form of nodules of fibrous consistency or actual phleboliths, may be felt in not a few of the varicoceles seen in old people.

4. *Hernia.*—There is apparently a general impression that varicocele tends to the production of hernia. Of this I have been unable to find any real evidence. That hernia will occasionally co-exist is quite certain, seeing the large number of people who are affected with varicocele, but there is, I believe, no reason to suppose that hernia of the *acquired* kind is more frequent amongst the subjects of varicocele than in others. It is, however, possible that the same tendency to abnormality, which accounts for the malformation in which the varicosity originates, may also give rise to the defect upon which the existence of a congenital hernia depends, but of this I have no proof.

5. *Mental distress.*—In addition to the distress and exhaustion of the kind produced by sexual irritation, there is seen in some, fortunately rare,

cases a condition of mental anxiety of a very remarkable sort, resulting from the continued concentration of the patient's mind upon his complaint.

This symptom is seen, so far as men are concerned, only I think amongst those who suffer from varicocele or who are the victims of real or imaginary disease of the rectum. The patient is usually a lymphatic individual leading a sedentary life, whose every thought dwells upon his complaint. He goes from doctor to doctor, and probably, at some time, finds his way to a 'quack' who, knowing well how to act for his personal gain, adds to the misery of the sufferer by gloomy prognostication of various evils. Every accessible book on the subject is eagerly studied, and gradually the patient is convinced that every symptom connected with the disease has developed. Ultimately he becomes a kind of monomaniac, and may contemplate suicide. Should an unwary practitioner be persuaded to operate, but little relief is likely to be obtained, since the man's extensive acquaintance with the literature of the affection is probably sufficient to enable him to anticipate, and after the operation generate the belief, that he is the victim of all the unfavourable consequences which are possible from such treatment. In less exaggerated cases of this kind treatment is more hopeful, as I shall show later on.

6. *Arrested development of testicle.*—This complication is fully discussed in the section on the condition of the testis.

Such complications as may be considered to be related in any way to the causes of varicocele are described under that head.

Time of Appearance of Symptoms, or Discovery of the Affection

As I shall attempt to show when the causes of varicocele are discussed, the time of the appearance of symptoms has really no direct relation to the period of the actual commencement of the disease, for, even in a well-marked form, it may exist throughout life without giving rise to inconvenience of any kind, and indeed without having been discovered.

Setting aside the question of injury, it is rare to be consulted by a patient on account of varicocele under the age of puberty. Most of the cases seen occur between puberty and the age of twenty-five, subsequently becoming gradually less numerous till the age of thirty-five is reached, after which they are rare again, excepting in nervous or hypochondriacal subjects, who have discovered the disease by accident, especially about the time when the virile powers begin to decline.

Including all classes of cases, with the exception of those applying for treatment on account of injury, the youngest are provided by accidental discovery of the affection or by rejections of candidates for the Navy, and the oldest by persons (1) who have long resided in tropical climates in whom at a late period of life symptoms, referred to the testicle, arise, or (2) those who suffer from passive thrombus due to gout or feeble circulation, in whom the occurrence of the clot often leads to their learning for the first time that they are the subjects of varicocele.

The oldest patient I personally have been called upon to treat was a man seventy years of age, the youngest a boy of eight, who had received a blow upon a large varicocele from a cricket-ball.

In 126 cases of all kinds seen in hospital and private practice, five were in patients under the age of twelve, eighty-two were first noticed between puberty and the age of twenty-five, twenty between twenty-five and thirty-five, the remaining nineteen occurring at later periods, the oldest patient being the one seventy years of age already mentioned.

It is essential to observe that these 126 patients included only those who applied or were brought for treatment, either for the varicocele itself, or for some symptom directly connected with it.

The accompanying table gives the details as to time of appearance in 100 hospital cases seen consecutively.

TABLE II

Showing the age at which the varicocele was first observed by the patient, in a series of 100 *hospital cases.*

Age	12 or under	12 to 20	20 to 30	30 to 40	40 to 50	50 to 60	60 to 70	80 to 70
No. of cases	6	28	42	14	5	3	2	100 (total of series)

The causes which led to the patients under the age of 12 being brought for treatment were as follows: injury 1, suppose hernia 2, parents thinking 'something was wrong with the parts' 2, to avoid rejection as naval cadet 1.

The majority of those about the age of 20 applied for treament to meet the requirements of the public services as to physical fitness. Between the ages of 50 and 70 the causes of application were, painful testicle (in patients who had long resided in tropical climates), thrombus, or injury.

CONDITION OF THE VEINS

1. *In the normal state.*—In the recognised text books on anatomy, the arrangement of the spermatic veins receives anything but a full recognition. In 'Quain's Anatomy,' ninth edition, it is thus described: 'The spermatic veins proceed upwards from the 'testicle and epididymus, and form in the spermatic 'cord a thick plexus of convoluted vessels, known 'as the *spermatic, or pampiniform plexus.* Passing 'through the inguinal canal into the abdomen, in 'company with the spermatic artery, the branches 'from this plexus join in two or three veins, and 'these again unite into a single vessel which ascends 'beneath the peritoneum on the surface of the psoas 'muscle, and opens on the right side into the vena

'cava, and on the left into the renal vein. The 'spermatic veins sometimes bifurcate before their 'termination, and, in this case, one branch may enter 'the vena cava, and the other the renal vein.'

In addition to these details, the following points are noteworthy, especially in relation to varicocele :—

(*a*) The left vein is always longer and larger than the right, moreover, it receives *one or more (generally two) branches from the descending colon.* These *colico-spermatic* branches, which communicate with the radicles of the portal system, vary greatly in size in different individuals, being in some cases very small, and in others so large that their combined calibre exceeds considerably that of the spermatic vein itself. These branches are normally entirely confined to the left side, the right vein being without tributaries, excepting a branch from the ureter which is found on both sides.

(*b*) The junction of the two, three, or more branches proceeding from the pampiniform plexus to form the spermatic vein may take place at any point between the level of the external abdominal ring below and the middle of the iliac crest above, the commonest situation being either just below the upper end of the inguinal canal, or immediately inside the abdomen above the internal abdominal ring.

(*c*) The pampiniform plexus is for practical purposes divided into two distinct portions, an upper

and a lower, by a central complicated plexiform arrangement. Above and below this, although the veins communicate with each other, the arrangement is in many cases hardly sufficiently intricate to justify the use of the term 'plexus.'

(*d*) The valves in the plexus and veins are uncertain in number and situation. They may be absent altogether, or may be very numerous. They may exist in great numbers in the plexus, and be absent in the spermatic veins, or *vice versâ*.

Under all ordinary circumstances they are more constant in occurrence and more numerous in the central plexiform arrangement, to which reference has been made.

In the spermatic veins there is usually a valve at the junction with the renal. This valve is more frequently absent on the left side than on the right; its absence on the left may or may not be associated with a more or less complete valve in the renal vein.

However numerous and competent the valves may be, they tend to become incompetent, as a rule, in subjects over sixty years of age. The defect thus arising is followed by slight enlargement of the veins below the level of the insufficient valves. The tendency to insufficiency in the vein valves of elderly people is not, of course, peculiar to this region, but occurs in the majority of long veins, notably the internal saphena.

2. *In abnormal subjects.*—Abnormalities are rare

on the right side, but comparatively common on the left.

Setting aside the variation in the level of junction of the efferents of the pampiniform plexus, which hardly comes under the head of abnormality, the left vein was found in 200 cases examined to present some distinct abnormality in nearly 25 per cent., whilst on the right side the percentage was not more than 5. Again, on the right side the abnormalities were trivial, consisting, with two exceptions, of bifurcation of the vein high up, both branches then running into the vena cava. The exceptions were: (1) a case in which there passed from the spermatic vein about its middle to join the renal a thin fibrous cord, small and not perceptibly pervious; in the renal vein was a fairly formed valve, and it is interesting to note that in two of the other instances of bifurcation there was evidence of the existence of an imperfect valve in the renal vein; (2) a case in which the right spermatic vein opened into the renal, and was considerably more than double the size of the left, having also opening into it large colico-spermatic branches, which were entirely absent on the left side. The veins of the pampiniform plexus were altogether larger throughout than on the opposite side. The ureter was double on the right side, but natural on left. I have recently met with another case showing the same abnormal arrangement, which

amounts in fact to a transposition of the right and left spermatic veins. Here, again, the ureter was double on the right side, a point which seems to indicate, as it were, some excess of developmental eccentricity in the production of this abnormality.

The abnormalities on the left side were roughly as follows :—

(*a*) Bifurcation of the spermatic vein before its termination. In most of the cases one branch opened into the renal, and the other into the vena cava, but in some the two divisions opened into the renal, and in one both ended in the vena cava.

(*b*) Division into three branches (only two examples of this arrangement were seen). In one instance, two of the branches terminated in the vena cava, and the remaining one in the renal ; in the other, the first branch entered the vena cava, the second opened into the renal, and the third, very large, joined a vein of considerable size on the back of the colon ; in this case, the whole spermatic vein was much larger than usual, and there existed an extensive varicocele, the upper end of which extended quite an inch above the internal abdominal ring.

(*c*) Double vein ; both vessels opening into the renal by separate orifices, or joining only at the point of junction with the recipient vein. In a subject recently dissected, the vein being double, one portion went to the vena cava, and the other to the renal,

having received just before its termination a large vein coming down from region of the spleen.

(*d*) Vein double about central portion, single above and below.

3. *In varicocele.*—In this condition the veins are not only larger and more tortuous than normal, but in many cases much more numerous. The relative number of the veins differs greatly in different examples, but, as a rule, varicoceles with very large and manifestly over-tortuous veins have fewer vessels than those in which the swelling is smoother and more compact.

The arrangement of the veins differs so much that four distinct varieties of varicocele are recognisable :—

(*a*) The tortuosity and dilatation involves the whole of the pampiniform plexus and its efferents (Tumour, Class I.), and may, therefore, when the junction of the efferents in forming the spermatic veins takes place at a high level, extend inside the abdomen. This latter statement is directly opposed to the belief of some observers who deny, or have great doubts about, the existence of intra-abdominal varicocele.

(*b*) The varicose condition may be more particularly limited to the portion of the plexus *below the central plexiform arrangement* to which I have alluded. In this variety, which is seen clinically

in Tumour, Class II., the veins in the upper part of the cord, beyond being rather larger than usual, are not abnormal, and this increase of size in some cases is so slight as to escape notice altogether.

(*c*) The varicosity may involve more especially the part of the plexus *above the central plexiform arrangement* extending up to the point of formation of the spermatic vein (Tumour, Class III.), the veins below being full, perhaps more numerous, but not generally much larger than normal. In this variety the valves in the central plexus are numerous and strong.

In speaking of the clinical aspects of Tumour III., I have referred to its tendency at later periods of life to assume the general characteristics of Tumour I., in consequence of the whole pampiniform plexus becoming involved. It is not, I think, unfair to assume that the change has some relation to the incompetency which is prone to occur in the valves in the central plexus, in common with those in many other veins, as age advances.

(*d*) The whole pampiniform plexus and spermatic vein may be much larger, more tortuous, and altogether more important than normal. I have dissected two examples of this variety. In each of these the varicose condition was uniform throughout the spermatic venous apparatus. The valves were proportionately large and strong and the vein walls

very thick. The vessels themselves were not more numerous than on the opposite side. The subjects were robust men who had died from acute disease, and no trouble had obviously been caused by the abnormal veins.

These cases may be regarded, I believe, as examples merely of congenital exaggeration in size of the veins, a view which is strongly supported by the facts that the testicle, in spite of the large size of the lower part of the varicocele, was in each case perfectly natural, and the *spermatic artery considerably larger than that on the unaffected side.* Similar cases occur in the lower extremities and in other situations, varying in degree from slight exaggerations in size only, to the condition sometimes called diffused venous nævus which may involve a whole limb. As already stated, the veins in varicocele are not only changed in character but in many cases (probably the majority) increased in number. This increase is most marked in the *second* of the varieties just described, and is very frequently present in the *third* kind; in the *first* it is comparatively rarely found, and in the *fourth* the veins are not more numerous than normal.

In all cases the vein walls are thicker than those of normal veins, the thickness bearing a direct proportion to the size of the vessel, a condition which leads to the open-mouth appearance shown by these

vessels on section. This unnatural thickness of the vein wall has been almost universally ascribed to the result of chronic inflammation upon, so far as I can judge, no evidence of any kind. It is much more likely, indeed in my opinion it is certain that, with very few exceptions in which thrombi, &c., have occurred, the thickness is merely the outcome of the same tendency to abnormality which produces the increased size and tortuosity, for it will be found that, however young the subject may be, the veins on the affected side are distinctly not only larger but thicker in structure than natural.

Condition of the Testicle

In 120 hospital cases examined with special reference to the condition of the testis in well-marked varicocele, there was clear evidence of want of proper development in eighty-one. In sixty of these the gland was considerably softer and more flabby than that on the opposite side when the affection was limited to one side, and distinctly softer on one or both sides when the disease was double. In fifteen the testicle involved was distinctly smaller than the opposite organ. In the remaining six cases the testicle was very small and hard, having very much the feeling of a fibroma; in one of these cases it was not larger than a hazel-nut. Four of these six cases were associated with evidence of old syphilis,

and the opposite testis had in them undoubtedly been the seat of syphilitic disease. The smallest testicle of all was in a patient who was perfectly healthy in every respect; the varicocele was not very large, and consisted of a mass of veins concentrated around the small testis. In one of the cases the testicle was said by the patient to have wasted after an operation on the varicocele six years before coming under my observation.

In these eighty-one cases no instance is included in which the abnormal state of the organ was imperceptible to others. Personally, I thought that fifteen of the remaining thirty-nine cases included in this series of 120, showed appreciable relative softness of the testis, but as this was not perceptible to any member of my class I have excluded them.

Testicular sensation was entirely absent in the six instances of very small testicle, and of the sixty cases in which the testicle presented varying degrees of softness there was distinct modification of this peculiar sensation in twenty-seven, the deficiency in the sensation appearing to bear a direct ratio to the softness of the organ, excepting in two instances in which the sensation appeared to be over-acute, but as both the patients so affected were very nervous, semi-hysterical subjects, the proper estimation of the symptom was next to impossible.

The only cases in which evidence of the testicle

having been at any time larger than when examined by me could be elicited, were in the four syphilitic patients, and in the example of wasting after operation. In these five instances wasting in the true sense had undoubtedly happened.

I have been entirely unable to trace any evidence of the testicle having diminished in size in any case of varicocele in which syphilis or gonorrhœa had not been an evident contributary cause to the wasting, or in which an operation had not been performed. Wasting from this latter cause should not occur—a point which will be fully dealt with subsequently.

The explanation, therefore, of the majority of these small or soft testicles in varicocele is not that they are in the true sense wasted organs, but that they have never attained a perfect state of development, in consequence of their growth having been arrested by the rapid general increase in the varicocele which so often occurs about the time of puberty. In fact, the growth of these testicles virtually ceases at puberty.

That the rapid general increase of a varicocele at the period named would be sufficient to bring about this result is fairly clear, if due consideration be given to the immense disturbance which must be produced, in the circulation of the delicate secreting structure of an organ like the testis, by backward

pressure resulting from such extensive changes in its efferent blood-vessels, especially as these changes occur at a time when the organ is in a peculiar condition of developmental excitement. This explanation seems to me sufficiently sound, and I do not think it is necessary to adopt the ingenious theory of Mr. Pearce Gould ('Clin. Soc. Trans.,' vol. xiv., page 82), that actual transference of developmental stimulus from the testicle to the veins takes place; the truth in reality being that under natural conditions this developmental stimulus affects the testicle not more than the structures immediately around it, and the veins, in consequence of their having already been abnormally numerous before puberty, only *appear* to have received an excessive share of the stimulus.

At the same time it is clear that this explanation does not account for the cases in which the testicle is very small as compared with the opposite side, since that condition may exist long before puberty. In one of my cases, for example, the patient being a boy of eight, who was thought to have a hernia with a retained testicle, there was merely a considerable varicocele with a round nodule not larger than a small bean representing the testicle, lying at the bottom of the scrotum, surrounded by a mass of veins, the other testis being at least three or four times as large.

Such cases can only be explained by assuming that the testicle has entirely ceased to grow at a very early period, indeed, development in the proper sense seems to cease at or soon after birth.

A difficult point in the cases in which the testicle appears to grow up to about the time of puberty, is to ascertain what determines the exact amount of deficiency of growth, for the largest varicoceles are not necessarily, and, indeed, not commonly, those in which the testis is most imperfect.

With reference to this point, the following facts are interesting and to some extent perhaps afford an explanation. From my own observation I believe that the testicle is least developed in those varicoceles of which the part immediately around the organ consists of a large number of small veins, rather than in the very large tortuous type of varicocele in which the veins, although larger, are much fewer. Now the varicoceles in which the testicle is buried in a mass of not very large veins belong to the type which is especially prone to grow with considerable rapidity about the time of puberty; on the other hand, the large vein type, involving the whole spermatic plexus equally, grows only, as a rule, with the individual and not in any disproportionate way at this period. The deductions I draw from these facts are as follows :—the large vein type consists of an excessive development in size of the veins with-

out increase in number and without tendency to erratic growth. The testicle is therefore not at any time subjected to great alterations of blood pressure to which it is unable to accommodate itself; this type being in fact identical with the cases occurring in the lower extremity, to which I have called attention, in which the whole limb is packed full of large veins which give rise to no inconvenience whatever, and often remain unnoticed by the patient unless discovered by accident or after injury. In such cases the arteries of the limb are frequently larger than those on the opposite side, and in the large general type of varicocele the spermatic artery is also sometimes much larger than that on the unaffected side, a condition which is never met with in the type in which a mass of small veins exists about the testicle.

The amount of arrest of development therefore, in my opinion, depends more upon the original *excess in number* of the veins than in their *excess in size* without great increase in number, since the former condition, in consequence of a rapid growth at puberty, may check testicular development by disturbing the circulation of the organ, whereas the latter rarely, if ever, increases with sufficient rapidity to interfere with the growth of the testicle. Moreover, if growth in the veins should occur, in the latter case, the increased size, when present, of the spermatic artery would be of much assistance to the growing

organ in overcoming the disturbance in its vascular system.

Roughly, then, it may be said that the testicle does not reach its normal development as shown by defective size, consistence, or testicular sensation, in rather less than 70 per cent. of all cases of varicocele.

In these, a certain percentage, which must be very small, the testicle is functionally imperfect also, a matter of little consequence when the affection is single, but when double, it may be of much importance since sterility may ensue, provided that both testicles are sufficiently at fault, a contingency hardly likely to occur with frequency enough to make cases of the kind other than curiosities.

Sterility in connection with varicocele, if such occurs at all—as, from the circumstantial evidence afforded by two cases which have come under my observation, I believe it does—is nearly always due, not to the actual absence of functional power in the testicle, but rather to the exhaustion of the secreting process by the constant irritation direct or reflex produced by the affection in some instances, a point which will receive a full consideration when I deal with the relation of varicocele to certain sexual conditions.

It is a matter of common knowledge that more than one observer has shown spermatozoa in the

perfect form to be absent at times from the spermatic fluid of individuals suffering from varicocele. Unless these observations extend over a period so long as to be hardly practicable, the fact is of no value in estimating the relation of varicocele to possible sterility, since the spermatic fluid of individuals who do not suffer from the affection must vary in quality from time to time unless it differs from all other secretions.

Causes

The causes of varicocele are of two kinds: (1) *originating*, i.e., those accounting for the actual existence of the affection, and (2) *contributary*, or those which affect its growth with or without the development of symptoms of inconvenience, discomfort, or pain.

The first of these causes applies with equal force to the occurrence of the disease on the right or the left side; the second affects it more especially on the left side only, for reasons to be considered.

Originating Causes

One cause only is concerned in the actual origin of the affection, viz., congenital abnormality, or malformation in the spermatic venous apparatus.

The extreme relative frequency of cases involving the left side as compared with the right can only be

explained by the fact that gross congenital abnormalities whilst common on the left side are rare on the right; a point to which full reference has been made in dealing with the condition of the veins.

Why these abnormalities should differ so much in frequency on the two sides is a morphological problem the solution of which is not easy, although it is without doubt to some extent connected with the great importance of the left vein in comparison with the right, not only in size, but in the complication of its arrangement and connections which I have shown to exist.

The abnormal conditions are found, as I have stated, in two forms: one characterised mainly by an exaggeration in size of the veins which are otherwise natural; the other is especially marked by an increase in the number of the vessels. In some cases the two conditions may be combined, but, as a rule, one or other will predominate sufficiently to indicate the type to which any individual case belongs.

The proofs of the congenital origin of the affection lie principally in the following points:—

(*a*) *The accidental discovery of the majority of varicoceles in a well developed stage*, no discomfort or inconvenience of any kind having been caused. Patients, when first made acquainted with the existence of the complaint, not infrequently remark that the parts have been always in the same state, not

having considered that there was anything unnatural about them.

(*b*) *The early age at which fully developed varicoceles are discovered.*—I have seen well-marked specimens of the large vein type in boys five, seven, and eight years old, the patients and their parents being entirely unaware of the existence of the condition, no change having occurred after birth in the affected parts sufficient to attract attention.

(*c*) *The state of the testicle*, which in some cases has been arrested in growth at a very early period of life. Together with this must be taken the fact that, excepting after operation or concurrent disease, there is absolutely no evidence of wasting of the testicle in these cases, in the true meaning of the word.

(*d*) *Results of dissection.*—I have seen a well-marked varicocele in a boy under four years of age in the *post-mortem* room, the spermatic vein and plexus being very large and somewhat tortuous. Amongst a number of fœtus examined, there was found in one instance well-marked abnormality of the veins on the left side, which were not only larger and more tortuous than those on the opposite side, but also much larger than the corresponding veins in a natural subject of the same age. In another fœtus the veins were sufficiently large and abnormal in the pampiniform region to leave no doubt that,

had it survived, a condition represented by a varicocele must have resulted.

(*e*) *Heredity.*—In 100 cases there was a distinct history of heredity in about fifty; in thirty of these the history pointed to varicocele, in the remainder of varix of the lower extremities. In a typical case, the patient being one of a family of four boys, two brothers had varicoceles, and one both varicocele and varix, the father who brought the patient having most exaggerated varix of both lower limbs, as well as a varicocele.

(*f*) *Frequent co-existence of other vascular abnormality.*—At least 85 per cent. of persons coming under observation with varicocele present evidence of varix in other parts, scars of old nævi, &c.

It is impossible to avoid being struck by the singular fact that this congenital origin has not received more support than it has done from previous observers, by whom it seems to have been regarded merely as an occasional or rather possible cause only. Thus Landouzy in his monograph, which is so universally quoted, does little more than hint at this origin. Mr. Henry Lee as recently as 1870, in a lecture on varicocele, in which the various supposed causes are enumerated, merely suggests the possibility of 'some inherent predisposition in the 'vessels themselves,' when speaking of heredity. Mr. Pearce Gould, in 1880, comes nearer the mark in at-

tributing the disease to a 'primary growth of venous 'tissue,' but in no work am I able to find any sufficiently definite stress laid upon the actual congenital character of the affection.

Contributary Causes, or those affecting the Growth of the Disease

In considering the causes which determine the increase in the affection, it is necessary to call attention to the following views relating to the manner of its growth which, although to the best of my belief now advanced for the first time, are based upon personal experience, and are in my opinion sound. Varicocele is liable to more or less rapid increase at two periods of life: first, at or a little before puberty; secondly, at some subsequent time, which is, as a rule, before the age of thirty-five.

The increase at puberty may cease almost immediately after that period, or may steadily but slowly continue for a long time.

This growth at puberty, even if it ceases directly, does not render subsequent increase less likely; in fact, *cæteris paribus*, varicoceles which rapidly enlarge at this time are more liable to increase again at a later date than those which have been unaffected in this way. The growth at the time of puberty or before is for the most part, if not entirely, limited to the type of the disease represented by tumour,

Class II., the bulk of which is formed by a mass of small or moderately sized veins concentrated about the testicle, and in the lower portion of the pampiniform plexus. Increase at a later date may occur in either type, but is more liable to affect the small vein class than that which consists of generally large and tortuous vessels. In short, the more the type approaches the character of mere exaggeration in size of the veins, as distinguished from increase in their number, the less likely is growth at any time to take place beyond that which is proportionate to the growth of the individual.

One other important point in this connection lies in the fact that varicoceles affecting the right side, whether existing alone or in common with a similar condition on the left side, rarely if ever commence to increase excepting about the time of puberty. In double varicocele, growth may occur at an earlier or later period on the *left side*, whilst the affection on the *right* remains quite stationary.

Now for the causes. (*a*) *Of growth about the time of puberty.*—This form of increase is solely to be attributed, in the first instance, to the increased developmental activity which affects the testicle at this time, with all the parts, especially the vessels immediately connected with it. Hence, it is only natural that the small vein type of the affection should show the greatest tendency to this increase,

seeing that it, for the most part, consists originally of a large increase in the number of small veins intimately associated with the testis and epididymus. This growth, in truth, represents a rapid increase in bulk of a quantity of venous tissue already much in excess of the normal requirements of the parts. The effect of this rapid development of accessory venous material is to so disturb the balance of the arterial and venous circulations, that the development of the testicle is arrested in a degree proportionate to the amount of this disturbance, a matter which has been considered in the section describing the condition of the testis.

The large vein type, in which the condition is rather an increase in size and tortuosity of otherwise normally disposed vessels than anything else, also, it is true, increases to some extent at puberty; but this increase is clinically of no importance, because it is proportionately not more, either in itself or in relation to the growth of the individual, than that which occurs in normal vessels in the neighbourhood of the testicle during this time of extra developmental excitement. In these cases, therefore, the testicle, for reasons already shown, is not so liable to any check in the completion of its perfect state.

These observations must be held to apply to the two types in their original forms. The occurrence of long-continued increase at puberty, or repeated

growth at later periods, may so affect the whole pampiniform plexus as to make the small vein class of the affection ultimately so closely resemble the large vein type, that careful examination is necessary to distinguish between the two clinically. On the other hand, the large vein type in its increase does not change in character at all, since the large vein peculiarity is retained throughout. It is, therefore, distinguishable by the absence of the softish compact cushion of small or moderately-sized veins, which in the other class envelopes the testicle.

(*b*) *Of growth at periods other than that of puberty.*—As a general statement, it may be held as true that any increase in the tension of the varicocele due to obstruction of the blood stream to a sufficient degree and for a long enough period, whether continuous or intermittent, may cause an increase in the affection itself, especially if there be an innate tendency to growth, such as exists in the small vein type.

It is also, in my opinion, true that the disturbing causes necessary in the large vein type must be much greater to produce enlargement, since the innate inclination to growth is wanting. The slighter exaggerations of tension constantly repeated may, however, produce some increase of fulness or tortuosity of a temporary, or rarely permanent, form, varying in proportion to the degree of extra pressure, but this entirely differs from the real increase which

occurs under the same circumstances in the other form.

Theoretically, it may also be conceded that any condition in which the support natural to the veins has been removed or modified would contribute to their distension and possible over-dilatation. Practically this factor is very unimportant, as there is nothing to support the view that the withdrawal of the natural support, which is supposed by some to be afforded by the scrotum, has any relation to the true increase of the disease, as I shall attempt to show. The state of the cremaster muscle has, however, I think, a certain relation to the amount of distension possible in a well-marked varicocele.

The whole of the conditions hitherto classified as initial causes can only be included, with any semblance of reason, under the head of contributary causes, since it is impossible that they can have any relation to the affection, excepting in so far as they affect its growth.

Further, it can hardly be said that, setting aside the actual obstruction of the blood stream by the pressure of tumours, there is any evidence whatever of either of these so-called causes being even contributary. Certainly neither of them deserves serious consideration in this respect, excepting residence in hot climates, and perhaps constipation, which, although it does not actually influence the growth

in the sense it is often understood and described to do, bears an incidental relation to the disease which is at least interesting.

Accepting the view which seems fair, viz., that the factor which leads to the growth at these later periods is increased intravenous pressure, the question arises as to what is the cause of this pressure, which in the large vein type may, if sufficient, produce additional general enlargement, and in the small vein class afford the impetus to actual growth, such as is met with in some of those cases.

The explanation which appears to me the most reasonable is afforded by the direct connection of the spermatic vein with the portal system, by means of the colico-spermatic branches, which I have described; for it is clear that although these vessels vary greatly in size in different subjects, they are large enough in some to allow any engorgement or obstruction of the portal circulation to throw increased pressure upon the spermatic vein, especially if by chance, as mentioned in one instance, any immediate communication existed with the trunk of the mesenteric vein.

The pressure thus arising would of necessity bear a direct ratio to that in the portal system, but for practical purposes it would depend in degree upon the size of the colico-spermatic veins, which are sometimes so small that the amount of backward

pressure transmitted through them could hardly affect the tension in the spermatic circulation to any appreciable extent.

If the grounds upon which this view is based are at all sound, it follows that the liability of varicocele to increase at periods subsequent to puberty must depend, to a great extent at all events, upon the existence of a sufficiently free communication between the portal system and spermatic veins, by means either of large colico-spermatic branches or possibly in some cases by more direct connection with the large branches of the portal vein.

To produce actual proof of this is impossible, since it could only be provided by dissection of a large number of subjects known to have had varicoceles which had increased at the time now being discussed. Circumstantial evidence of considerable weight is, nevertheless, forthcoming on the following points :—

1. It is, I presume, generally known that the growth of varicocele at these later periods is not unfrequently associated with the development of piles, and that remedies which remove the feeling of weight and discomfort about the rectum in such cases have an equally good effect upon any feeling of distension about the varicocele; these remedies being, for the most part, drugs which directly excite the secretion of the liver, and so relieve the tension in the portal system.

2. Residence in hot climates, especially in India, is admitted to be a cause of this kind of increase; it is also an admitted cause for the development of piles. Now, although the increase of the disease in hot climates is to some extent more frequent than in this country, the difference is very slight, and certainly not more than could be accounted for by the well-known tendency to liver derangements, with resulting portal engorgement, which is so prevalent in certain climates. Even then it seems obvious that the increase of the disease must depend upon some peculiarity of the veins, otherwise it should affect a much larger proportion of cases than it actually does. Again, it would affect both sides equally, which it surely does not do.

The cause to which the increase in hot climates is usually ascribed, is the general relaxation of parts which is produced by the extreme heat, &c.; the result being the loss of the natural support supplied by the relaxed tissues. Although this may give rise to some fulness and discomfort, I have never seen any reason to infer that actual growth could be thus produced, for if it were so, the effect would be altogether more uniform in its distribution over the aggregate number of cases influenced by this supposed cause.

3. Varicoceles on the right side rarely, if ever, increase, except at the time of puberty; those of the

left side not uncommonly do so at later periods. I have already said, in cases in which the affection is double, that on the left side may grow, whilst that on the right remains unchanged. Here, again, it seems clear that this tendency to growth must be associated with some peculiarity in the veins on the two sides, and the only constant difference, excepting in the way of size and length, which could affect the matter at all is the frequent communication with the portal system, which is normally entirely limited to the left side, and is sometimes very free. It is on the whole, therefore, not altogether unreasonable to connect the relative frequency of increase on the left side with the occasional existence of this free communication.

I now come to the relation of constipation to the increase of varicocele. I much doubt whether it is anatomically possible for a loaded colon, under any circumstances, to exert direct pressure upon the spermatic vein sufficient to merit consideration. Moreover, it has been shown again and again that the increase in the affection may, and does, occur quite independently of constipation, whilst, on the other hand, constipation of the most exaggerated kind frequently co-exists with varicocele without influencing its growth in any way.

This condition may, therefore, be regarded merely as an incident due possibly to the same cause as the

increase of the varicocele, and having no other relation to it, the cause referred to being engorgement of the portal system which may, however, occur without producing constipation, thus explaining the frequent absence of any relation between this condition and the growth of varicocele. In the same way constipation is frequently associated with piles, but it is not actually necessary for their production, and in fact often bears only the incidental relation to that complaint of being due to the same cause.

The following so-called causes may be safely regarded as having no real bearing upon the origin of varicocele :—

(*a*) Great length of the veins on both sides, and the manner of termination of the left in the renal vein at a right angle.

(*b*) Loss of valvular function. The valvular arrangements are altogether too uncertain and irregular in the spermatic veins and plexus to have any effect as a cause. Their presence, absence, or insufficiency may, however, affect the form of the tumour.

(*c*) Thinness of the vein walls. There is good reason for supposing that the veins in varicocele are *ab initio* thicker than normal. Further, there is no reason for assuming that the veins are under normal circumstances too thin to meet the physiological requirements of the part.

(*d*) Alternating fulness and emptiness in different

positions of the body. This is the universal character of the venous circulation in every part of the body, affecting all individuals in like manner.

(*e*) Petit's theory of the disadvantage to the circulation in the spermatic veins arising from their pulley-like relation to the pubic bone. Apart from other considerations, this is disproved by the fact that, although varicocele exists less frequently, and rarely grows on the right side, the bend in the veins on that side (the right) is quite as acute as on the left.

(*f*) Lenoir's theory, that the frequency of occurrence on the left side is due to the pressure exerted upon the veins of that side, as they pass through the abdominal ring, by the constant bending of the body to the right side during the lifting of heavy weights, &c. If this were so, then varicocele in left-handed men should occur only on the right side, which is not the case.

(*g*) Inflammation of testicle or scrotum. This condition is much more likely to cause some shrinking of the affection from the veins becoming blocked by thrombus, the result of extension of inflammation to the tissues around the vessels.

(*h*) Pressure of omentum in fat people (Astley Cooper). Varicoceles are not more common in fat people than in spare subjects.

(*i*) Sexual excesses. The relation of these to the causation of varicocele is discussed at p. 61.

Relation to the 'Physical Fitness' of Candidates for the Public Services

The ratio of rejections for 'varicocele' per 1,000 of all recruits for the army, examined in the ten years 1878–87, is shown in the table appended, in which I have placed, for purposes of comparison, in parallel columns the proportion of rejections for 'varix,' which may be taken to mean varicose veins of the lower extremities.

Table III

Showing ratio of rejections, on account of varicocele and varix, per 1,000 *of recruits examined for the army in the ten years* 1878–87. (*Compiled from the Annual Reports of the Army Medical Department.*)

Year	Primary Inspection				Secondary Inspection		Total		Total number of recruits examined
	Examined by Army Medical Officers		Examined by Civil Practitioners		Examined by Army Medical Officers		Ratio per 1,000 of rejections in total number of recruits examined, excluding a small number rejected as unfit within first three months of service		
	Ratio per 1,000 rejected		Ratio per 1,000 rejected		Ratio per 1,000 rejected				
	Varicocele	Varix	Varicocele	Varix	Varicocele	Varix	Varicocele	Varix	
1878	12·01	17·30	12·54	12·80	—	—	13·08	17·96	43,867
1879	12·92	18·10	16·32	17·27	—	—	14·77	19·22	42,668
1880	13·70	15·40	22·54	15·57	—	—	16·09	16·14	46,108
1881	16·23	16·28	14·40	15·06	—	—	16·86	17·20	47,444
1882	16·93	16·43	10·56	12·60	5·60	6·62	16·82	16·97	45,423
1883	16·79	14·89	18·45	13·24	7·40	6·98	18·27	15·80	59,436
1884	13·26	16·63	20·81	12·83	7·71	9·60	15·85	17·69	66,882
1885	15·67	16·62	15·68	12·68	5·92	5·64	16·91	17·03	72,249
1886	15·93	18·00	20·35	12·41	5·27	5·84	17·74	18·14	74,991
1887	13·28	17·79	22·76	14·41	4·62	5·50	15·39	18·11	60,976

A similar table relating to the navy would have been interesting, but the necessary information is not, I believe, obtainable.

It will be seen that, so far as varicocele alone is concerned, the ratio per 1,000 of rejections in the ten years dealt with varies from about thirteen to nineteen, and in varix from sixteen to twenty approximately.

There is, therefore, on the whole, a considerable excess on the side of varix, which is precisely what would naturally be expected, as the complications likely to arise in connection with varix in the sense it is here used are not only more numerous, but certainly more liable to render a soldier unfit for service. Indeed, it is to me a matter rather of surprise that the rejections for varicocele alone approach so nearly in number those for varix. In this respect it is curious to note that, whereas in candidates examined by army medical officers the rejections for varix exceed those for varicocele, in candidates examined by civil practitioners the rejections for varicocele are, on the whole, in excess of those for varix.

The explanation of this discrepancy is not at first sight easy, but the relatively small number of recruits examined by civil practitioners may possibly have something to do with the matter. It is, at all events, manifest that the combined rejections for varicocele

and varix amount to the large ratio of from 30 to 35 per 1,000 of all recruits examined, which is the largest proportion of all causes of rejection with the exception of those classified as 'under chest measurement,' 'under weight,' and 'defective vision,' whilst it is about equal to the ratio afforded by those sent back as being 'under height.'

The rejection of such a large number of persons on this account who are anxious to enter the public service leads to the fact, well known to all surgeons, that the majority of varicoceles submitted to the so-called radical cure are in patients who have either already been rejected or who anticipate rejection for the army or navy.

The question now arises as to whether there is actual justification for rejecting a young and otherwise healthy subject on account of a small varicocele giving no trouble, and indeed almost always unknown to its possessor until he has been made acquainted with its existence at the physical examination. The consideration of this point must of necessity have a place in a treatise which attempts to deal with varicocele in its various relations, more especially because surgeons of experience and distinction are sometimes heard not only to question the justice of these rejections, but to class them as distinct hardships. At first sight it must be admitted that there appears to be some ground for

this view, but upon investigation there is, I think, little doubt that the great majority at least of these rejections are justified by the exigencies of the public services as gauged by results. Speaking, of course, as a civilian, it is only possible to form any personal judgment on the matter other than that based upon cases seen in practice, and it is necessary to recollect in connection with this point that a large proportion of the men who are actually invalided, or who suffer inconvenience from one or other of the many affections to which they are liable, come ultimately under the care of civilian practitioners, either in public institutions or private practice.

That a considerable number of men passed into the army or navy with varicoceles subsequently suffer pain and inconvenience which in some instances may amount to perfect misery there is no doubt, and that a certain number are either invalided or leave the service on account of complications arising in connection with the complaint, is also certain. I do not suppose that a good soldier would be liable to be invalided for varicocele alone without complication, although it may possibly, I presume, be considered sufficient excuse for getting rid of a man who, for other reasons, was considered unfit for service, if those reasons were in themselves not enough to invalide. To the casual onlooker a very weak point about the whole matter is the singular

want of uniformity in the class of cases rejected at the physical examination of the recruits. It has occurred to me, as it has also to other surgeons, I suppose, to see more instances than one in which small and comparatively insignificant varicoceles have been considered sufficient cause for rejection, whilst men with the large pendulous form of the affection have been passed in.

Now, although in most of these cases I believe the decision is perfectly right, for reasons to be given presently, I cannot learn that this is based upon any definite characteristic of the varicocele, but depends only upon the views held by individual examiners, so that, assuming this to be the fact, considerable want of uniformity must of necessity result.

Further, it is also obvious that a slight varicocele, in a subject who appears physically not too strong in one or more ways may afford a fair, if not the only tangible excuse for his rejection, whereas a very robust, and otherwise perfectly healthy man, even though he had a large varicocele, may be thought far too promising a recruit to make it wise to send him back.

In addition to all this a certain amount of discrepancy in this relation is undoubtedly accounted for by the well-known fact that it is possible for candidates, by a little careful management and general discretion exercised for some time prior

to the date of their physical examination, to so modify, for the time being, the condition of the parts involved, that the affection is hardly noticeable except upon a more careful investigation than, for various and probably good reasons, is in most cases considered necessary. This factor, however, does not enter largely into the question, since it is confined almost entirely to those desirous of entering the services as officers. Apart from any of these collateral reasons for apparent discrepancies in the classes of case rejected, I am satisfied, after very careful attention to the matter, that the mere existence of varicocele as such is not necessarily any justification for the rejection of recruits. Again, size alone is no criterion whatever of the importance of the affection in the relation now under consideration (excepting, of course, that it predisposes to possible injury, which is hardly worth consideration in an otherwise sound subject), since the largest varicoceles are by no means those which most commonly give trouble later on in life.

In other words, I believe that the importance of this affection lies not in its size so much as in certain characteristics which indicate probability of growth with the accompanying liability to the occurrence of other symptoms. The question that naturally follows is this: Is it possible to distinguish between those cases which are likely to grow and those which will

probably remain stationary? Personally, I think it is quite possible to do this in the great majority of cases.

In another part of this monograph I have stated my belief that two distinct classes of varicocele exist — viz. one in which the veins are merely very large, but not much, if at all, increased in number, and the other in which the increase in number of the veins is in excess of the increase of size. Now, the first of these two classes involves the whole spermatic plexus freely, uniformly, and sometimes is associated with a correspondingly large spermatic vein, the whole vascular arrangement being in point of fact merely abnormally large, but not otherwise unnatural. In such cases growth out of proportion to that of the individual is rare, either at puberty or at any other time, and there is seldom associated with them any peculiar testicular change or excitability. The objective characteristics of this form correspond with Class I. of the tumours previously described.

The second variety, where the increase in the number of the veins exceeds the increase in size, shows itself (Tumour, Class II.) in the form of an aggregation of veins, some of which may be large, but the majority are of moderate or even small size, massed especially around the testicle. The affection here involves, for the most part, the lower portion of the pampiniform plexus, the upper portion showing

more or less dilatation, &c., but to a very much smaller extent than the lower part. In such cases, growth out of proportion to that of the individual is prone to occur at puberty, and at any time under certain conditions up to twenty-five or thirty years of age. Defective development of the testicle, with or without various symptoms of a direct or reflex nature, is common. Although the tumour in this second variety is always smaller and more limited than in the first, I have no doubt whatever that it affords a much greater justification for the rejection of a recruit, in consequence of its proneness to growth, than the large vein type, which, in an ordinary way, shows but little tendency to alteration of any kind.

Returning to the affection in its general aspect, and without regard to its several varieties, there appears to be no doubt that trouble is less likely to arise from it in some branches of the services than others; for instance, officers should enjoy an immunity from discomfort in consequence of their greater facilities for taking the necessary care which would be hardly obtainable by a man in the ranks. At the same time, as a set-off against this, must be considered the probability that the ordinary soldier would be less likely to note slight inconvenience than his superiors. Judging again from civil practice, the number of cases in which trouble arises is greater in

the cavalry and artillery than in line regiments, for in a considerable experience I have never had to treat actively an officer in a line regiment, excepting after long service in hot climates. In cavalry regiments treatment is not infrequently necessary, as might naturally be expected, for nothing could be more conducive to discomfort and pain than the ordinary military riding, or the jolting and strain which is inseparable from all artillery work. Although the symptoms thus produced may be to some extent modified by the use of suspenders or other contrivances, they obviously cannot be very effectually guarded against, especially when on active service.

The majority of candidates rejected on account of varicocele are informed, if otherwise sound, that they will probably be passed subsequently, if the affection has been submitted to the 'radical cure,' and they are, usually, so passed if a proper operation has been performed.

The question then arises as to whether operative treatment is effectual in obviating the occurrence of subsequent inconvenience, or at least in modifying it.

The answer may be given fairly and, I believe, with confidence in the affirmative sense, provided always that the operation is sufficiently complete.

I am aware that some surgeons regard the operation under these circumstances as somewhat a matter

of form, and not infrequently, as has already been mentioned, comment upon its hardship. I cannot help feeling that such an attitude is unfortunate, since it may lead possibly to the performance of operations which, whilst they may for the moment satisfy the requirements of the physical examination, are not sufficiently radical to effect the permanent change in the varicocele necessary to prevent or modify distressing symptoms later on. A condition of things which tends to discredit the radical treatment, and may place those responsible for the physical examination in a rather invidious position.

The two cases which follow are fair, and not exaggerated, examples of the manner in which trouble may at times arise and render active treatment necessary.

Case 1.—An officer, about thirty-three years of age, in a cavalry regiment, consulted me concerning a varicocele which he had found, for many years, very uncomfortable whilst riding. For ten years the discomfort had increased to actual pain, and at last the distress had become so acute that he decided that he could not remain in the army unless something could be done for his relief. He had spent some hundreds of pounds for treatment at the hands of surgeons, ordinary practitioners, homœopaths, and truss-makers, without any good result. He had been warned by two leading authorities in London,

and one of the first opinions in Ireland, against allowing any operation to be performed, as the size and general state of the affection rendered such a treatment too dangerous to life to justify it.

He had been passed into the army with a small varicocele, which soon began to slowly increase. The account he gave of his symptoms at our first interview was this:—All riding was painful, and to such a degree that, although a first-rate cross country rider, he was obliged to give up hunting as he could not face a fence in consequence of the pain felt in landing. Military riding, especially in hot weather, was most distressing, and a field day was almost more than he could stand. He was physically a singularly well-built man, in perfect general health. The varicocele was on the left side, large and very heavy about the testicle, which was a little over-sensitive on pressure.

After some difficulty, in consequence of the grave prognostications he had received on the subject, I persuaded him to have the 'radical cure' performed, as it seemed a great pity that a man of such physique should relinquish a profession to which he was greatly attached on account of symptoms which I was sure could be relieved by operation without any appreciable risk, in spite of the adverse opinions which had been given.

On April 1, 1889, I operated in the manner

described by me in the 'Lancet' (Feb. 9, 1889), excising two-and-a-half inches of the cord. Recovery was rapid and complete. He was up and about in the usual way a fortnight after the operation, and five weeks later mowed a heavy field of grass without pain or other inconvenience. Now, two years after the operation, no suspender being used, he is perfectly well, suffers no discomfort of any kind, rides across country as well as ever he did, and goes through the heaviest field day without a thought of his varicocele.

Case 2.—An officer in a light cavalry regiment, who had a double varicocele of very moderate size, which had become sensitive and painful whilst riding, especially in warm weather, consulted me as these symptoms were rapidly becoming more marked and the affection itself increasing on the left side.

I operated in the same manner as in the previous case, with a slight modification to be described later on, excising one-and-a-half inches of each cord. He was virtually well in a fortnight, and when last heard of, eighteen months after the operation, remained in perfect condition.

In this case it was also clear that continued increase of the symptoms must have made it impossible to remain in the service.

It is unnecessary to quote further instances, as these two are I think sufficient to prove, if proof

were wanting, that varicocele is undoubtedly in itself liable to give rise, not only to discomfort, but to distress sufficient to make robust men contemplate giving up soldiering. They also show the remarkable relief obtainable by appropriate treatment, even in such a strongly marked instance as the first.

The effect of long residence in hot climates, especially India, upon the growth of varicocele and other varicose conditions, is a matter of common knowledge.

The discomfort, or other symptoms liable to arise in varicocele under conditions of foreign service in hot climates, can, I have no doubt, be to a very great extent modified in most cases, and entirely obviated in many, by appropriate treatment, as these symptoms are generally connected either with the increase of the affection or the formation of thrombus in the immediate neighbourhood of the testicle, and therefore affect a portion of the varicocele which can be absolutely isolated, and 'cured' by a sufficiently complete operation.

I fully believe, therefore, that it is wise for any subject of varicocele about to go on foreign service of the kind indicated, to submit to the 'radical cure,' even if no trouble has previously been experienced. This course may with all the more confidence be recommended, as it is, in my opinion, quite safe in competent hands, the largest amount of risk that it

involves being that associated with the taking of an anæsthetic, which in some instances may be dispensed with altogether.

Relation to Certain Sexual Conditions

A reference to Table IV. (p. 68), giving the reasons which led to treatment being sought in 100 cases of varicocele, shows that 9 per cent. of the patients in that series suffered from the effects of some real or imaginary affection of the sexual function.

Judging from my entire experience, the percentage is rather higher than usual in this table, still the number of cases of this kind met with in practice is sufficient to make them worthy of careful consideration.

The relation of varicocele to sexual irritation, depraved inclinations and practices, does not, so far as I am able to judge from the literature of the subject, appear either to be properly understood, or to have received the attention it merits.

All the ordinary works dealing with the affection, whether in the form of special treatises or as parts of general systems of surgery, invariably refer to self-abuse and excessive venereal indulgence as causes of varicocele.

It is, however, perfectly clear, if a moment's thought be given to the question, that it is quite impossible for either of these so-called causes to origi-

nate the affection. Personally, I would go further than this, for I have no doubt whatever that the relation is quite the reverse of the commonly accepted view, as it seems to me certain that in those cases of varicocele in which any excessive perversion of sexual habit or inclination exists, the varicocele is the cause and not the result of the sexual irritation.

It is most difficult to surmise what the reasons could have been which led to the general acceptance of the opposite view, unless the growth of the disease being, as it so often is, coincident with the acquirement of the depraved habits was misinterpreted, as being due to the depraved practices, instead of the acquirement of the habit being caused by the irritation of the testicle by the growing varicocele, at a period of life (puberty) when the whole generative system is in a condition easily excited by direct or reflex causes.

My view, therefore, in relation to this point, is that the effect of the growth of the varicocele in these cases, which are fortunately not very common, is to produce an irritation in the generative organs which leads to exaggerated sensitiveness and at times insatiable desire, the rational and only logical treatment of which lies, not in the administration of a multiplicity of drugs or of comprehensive monitions as to the necessity for moral restraint, but in the removal or modification of the source of irritation by the radical

treatment of the varicocele by a proper operation; in short, to apply ordinary surgical principles and attempt to remove the cause rather than dally with the result.

I confess there has always appeared to me a singular want of consistence in the practice of those who, in a case of depraved sexual habit, would not hesitate to recommend the removal of a redundant prepuce as a possible cause of the irritation, and who would, at the same time under similar circumstances, hardly think of looking for a varicocele at all, and even if aware of its existence, would be satisfied with offering advice as to the practice of self-restraint, the possible source of the irritation being left untouched.

The following is an illustrative case. A youth just under twenty years of age came under treatment with a varicocele, which was rather large and sensitive on pressure. This varicocele had increased very considerably when he was about fifteen years of age, having previously given no trouble, although it had existed as long as he could remember. With the increase of the affection, sexual irritation developed itself, and when applying for relief the following was his account of the matter. Every morning on rising there occurred uncontrollable sexual excitement, which was sometimes so acute that until a sexual discharge occurred, spontaneously or otherwise, actual pain was felt. Distressed at his condition he

had sought treatment of more than one practitioner, and had received the same advice, which resolved itself in each instance into a recommendation to exercise self-control.

The radical treatment of the varicocele by operation entirely relieved these symptoms, and the change in the patient's aspect and general condition was most marked.

I have ventured to mention this case, in spite of its unpleasant aspect, in brief detail, and have spoken, in a general way, somewhat plainly on the question of sexual irritation, because I believe unnecessary hardship is occasionally inflicted upon these unfortunate patients by what seems to be a want of knowledge of the proper relation of cause and effect, on the part of those from whom advice is sought in some of these cases.

Again, the abnormally frequent nocturnal emissions which are undoubtedly associated with a certain percentage of varicoceles, are not infrequently attributed, together with the varicocele itself, to bad practices on the part of the patient. Actually, however, this symptom is commonly the outcome of this same irritation which I am discussing, and if relief is possible, it is not by medicine and good moral advice that it is to be obtained, but by operative measures. Here it is necessary to admit that all of these symptoms may be to some extent alleviated by the avoid-

ance of scenes likely to cause the excitement feared, by the total relinquishing of exciting drink and rich food, and by persistent healthy exercise and mental occupation.

At the same time, it must not be overlooked that such a *régime* is virtually impossible for the worst of these patients, since the continued existence of the source of irritation and excitement is enough in itself to prevent the exercise of the necessary self-control.

The result is that, if nothing is done for their relief, the hopeless depression which comes over some of these patients can only be allayed by drink or potent drugs, and occasionally leads to suicidal tendencies.

It is well known that the first anxiety of many men, especially if they happen to be advancing in life, upon the discovery that they are the subjects of varicocele or any other affection in the same locality, is with respect to its possible influence on their virility, a fact fully utilised by quacks and charlatans of every description from time immemorial. It is therefore necessary to refer as briefly as possible to those cases of supposed impotence which are occasionally seen in association with varicocele. Of real impotence under these circumstances I have never seen an instance, nor do I believe in its occurrence.

Temporary insufficiency of power may arise,

simply from apprehension, usually prompted by the evil prognostication of quacks or other ignorant or unscrupulous persons, especially in subjects about to marry after having led lives of dissipation. Great exhaustion from mere fatigue may affect also the genital organs in cases where the irritation of which I have been speaking has led to excessive sexual indulgence, or oft repeated involuntary emissions.

From this state of fatigue, which is simply the tire of over-use, any ordinary patient whose mental powers have not actually broken down will recover, if rest can be given to the exhausted organs. If, then, this necessary rest cannot be obtained in any given case without effecting the modification or removal of the source of irritation, the rational treatment is surely to try to attain this end by the radical treatment of the varicocele by operation. Of sterility in relation to this affection enough has been said under the head of the condition of the testis.

PART II

TREATMENT

It has been already shown that only a small proportion of the gross number of varicoceles give rise to any trouble or anxiety whatever, and that in many cases the existence of the unnatural condition remains quite unknown to the affected person throughout life. It may also be again stated that in a considerable proportion of the cases for which advice is sought no active interference of any kind is called for.

The causes which commonly lead patients to place themselves under treatment are well seen in the accompanying table (see next page).

The treatment of such cases as require it may be conveniently considered under three heads: (1) Mechanical, without operation; (2) medical; and (3) operative—i.e. the so-called 'radical cure.'

TABLE IV

Showing the causes which led to treatment being sought in a series of 100 *cases of varicocele, seen in hospital and private practice.*

—	Symptoms obviously in immediate connection with the varicocele, e.g., pain, tenderness, or discomfort							—	—	Sexual irritation, mental distress, and imaginary ills			Requirements of public services		—
Causes which led to treatment being sought	Sensations of weight, dragging, or general discomfort	Acute pain during exertion	Neuralgia of testicle	Pain and tenderness without obvious cause	Acute pain and tenderness from recent thrombus	Tenderness due to presence of phleboliths	Injury	Rapid increase in size without pain or discomfort	Supposed hernia for which the varicocele had been mistaken	Depraved sexual inclinations or practices	Supposed impotence, spermatorrhœa, &c.	Mental depression or anxiety	Rejection for public services on account of 'physical defect'	To avoid rejection for public services	Accidental discovery of the varicocele
Number of cases	8	6	3	5	2	2	3	12	4	3	6	4	16	11	15
	a 29%							*b* 12%	*c* 4%	*d* 13%			*e* 27%		*f* 15%

The cases included in the above table were seen consecutively, and came from all classes of society; they may, therefore, be fairly considered as a thoroughly representative series.

MECHANICAL TREATMENT, WITHOUT OPERATION

The object here in view is the prevention of pain or discomfort, and the diminution of liability to injury of the varicocele by affording proper mechanical support by which the weight of the testicle and large veins is entirely borne if the appliance is efficient.

This indication is usually sufficiently met by the use of one of the various suspenders obtainable

in endless variety at the several surgical instrument makers.

It is well to bear in mind that with suspenders, as with some other appliances—trusses, for instance —it is not easy always to be sure at first which variety is best suited for different cases, especially as the fancy of the individual usually somewhat affects the choice.

There is, however, one variety which rarely fails to effect the required object, and that is the apparently almost forgotten old-fashioned linen suspender, composed merely of a boat-shaped linen bag which hangs hammock-like from two tapes, one attached at either end and fastened around the waist after having been crossed behind the back. I have recommended this suspender in every kind of case almost exclusively for some years, and see no reason to alter my opinion of its effectiveness and superiority over all others. The comfort with which the scrotum and its contents are supported in this bag is almost as perfect as it can be. It is simple, easily made by any person who can use a needle, is cheaper than any other kind, and is also most cleanly, as it is not injured by washing. It may be obtained in various sizes. A very comfortable and cleanly form of support is a triangular handkerchief or piece of linen attached to a waistband, one angle being attached behind in the middle line, the other angles, after the

handkerchief has been brought forward between the thighs, being spread out over the external generative organs, and attached, by tapes, buttons, or safety-pins, to the band in front on each side. By this method the scrotum, testicles, and penis are kept applied to the lower part of the abdominal parietes or front of the pubes very comfortably. It is a good deal used by hunting men and cross-country riders for ordinary suspension of the parts, independent of the existence of varicocele. In a general way, however, it is rather troublesome, as, for obvious reasons, repeated readjustment is necessary.

Theoretically, the best of all suspenders for varicocele is that invented by Mr. Morgan, of Dublin (an illustration of which will be found in 'Bryant's Surgery,' 4th edition, vol. ii, page 240), by which the testicle on one side only may be actually slung. The apparatus is unfortunately rather complicated, as its efficacy depends entirely upon the adjustment of a piece of lead wire which retains the testicle in a laced bag suspended from a waistband; moreover, there are two objections to its use: (1) The wire is apt to be bent by accidental pressure, and may so cause discomfort and, possibly, injury; and (2) the arrangement can only be comfortably tolerated in cases in which the testicle is not tender or over-sensitive—i.e. in cases which least require any form of support.

The other varieties of suspenders are too well known to require special comment. All those containing elastic material should be avoided, as they rapidly perish when acted upon by the secretions of the parts, and are so spoilt by washing that cleanliness is only obtainable at unreasonable cost. In addition, the elastic material does not in any way ensure increased efficacy, whilst it adds to expense.

There is at present to be obtained an 'electric suspender,' which should be avoided above all others. Wormald's plan of providing a natural suspender for the testes by drawing a fold of the scrotum through an indiarubber ring and so shortening it, at one time enjoyed some popularity. It cannot, however, be used for a long period, as the scrotum, if much good is to be derived, must be so tightly constricted by the ring that œdema and other evils may result. At the same time, I have known two patients, requiring a suspender only occasionally, who obtained so much comfort from this method that they would adopt no other.

Considerable credit has from time to time been given to the use of trusses in the treatment of varicocele. Personally, they appear to me to be useless, and in most cases distinctly objectionable. It is true that, occasionally, some slight temporary benefit seems to arise, especially in the pain of a crampy cremaster, and, possibly, also in cases in which the

tumour is of the kind described as Class III. (page 7), which projects from the external abdominal ring somewhat like a hernia.

Any slight benefit thus obtainable is, however, entirely outweighed by serious disadvantages. I have, for example, seen thrombus occur as a direct result of the pressure of a truss; testicular pain may also be produced, and cases of actual wasting of the testicle from the same cause have been recorded. Curling speaks of varicoceles entirely disappearing during the use of the truss; personally, I have seen no such case, although in one instance which was under my observation there certainly appeared to be for a time a slight decrease in size, but the improvement was not permanent.

If a hernia co-exists, the use of a truss is naturally indicated, but in the majority of such cases occurring in healthy subjects an operation for the 'radical cure' of both conditions is probably a justifiable and more rational proceeding.

If a truss be ordered for a case of varicocele it should fit most accurately; the spring should be of very moderate strength, the pad small, and made of some hard material, such as vulcanite or boxwood.

Medical Treatment

On this head there is little to be said.

The main object is to modify or prevent increased

tension in the veins by the removal of obstruction to the blood stream, such as may result from liver engorgement, &c.

Careful attention must, as a matter of course, be given to the intestinal secretions. Feelings of weight and tension may often be alleviated if not entirely removed, although constipation may not exist, by a simple laxative containing sulphur. With evidence of inactivity of the liver mercury in some form is indicated; in constipation the simpler forms of purgatives, such as cascara or confection of senna, are usually effectual. Watery purges and enemata should be scrupulously avoided.

In nervous and hypochondriacal subjects attention to the digestive organs is of first moment, since many of the feelings of depression may after all be nothing more than the outcome of dyspepsia.

In the peculiar mental state which has been described as occurring in some subjects, rational advice, based upon some practical grounds likely to appeal to the reason of the patient, will sometimes effect a desirable change. Much help may also be derived in these cases from the use of phosphate of zinc and nux vomica, either singly or together. In young semi-hysterical subjects nothing appears to answer better than valerianate of quinine. In one of these cases which seemed likely to resist all treatment sumbul acted with remarkable certainty

In all cases of this kind medicines are really of secondary importance compared with the adoption of a healthy condition of life, that is to say, constant occupation, regular exercise, reasonable hours, and wholesome, not too stimulating, living. Depressants of all kinds, like the bromides, for example, should be put aside as distinctly harmful. They are, I am aware, recommended by some for the relief of the sexual irritation and fatigue which occur in certain of these cases, but on grounds which I believe to be entirely wrong, for reasons with which I have dealt sufficiently on page 61.

Electricity applied to the scrotum is sometimes stated to have been useful. I have tried this treatment experimentally in a few instances, with a view to the relief of feelings of weight and discomfort, with temporary benefit, apparently due to the contraction of the scrotal tissues and cremaster muscle, but the necessity for constant repetition of the treatment makes it too irksome for the ordinary patient, and for other obvious reasons its use is not desirable in the general run of cases.

It is often useful to know a reliable method of rendering a varicocele temporarily as small and unnoticeable as possible, especially in the case of a candidate about to present himself at the physical examination for the army or navy. The following plan will be found to answer well as a rule: (*a*) A

rather tightly fitting suspender should be worn day and night for at least a month before the examination. (*b*) For the same period the scrotum should be douched night and morning with icy cold water. (*c*) During the final week the parts about the varicocele should be bathed, after the douche, with a strong cold solution of alum. (*d*) On the two days immediately preceding the inspection the scrotum should be thoroughly well painted over several times with glycerine and tannin, the last application of which should be allowed to remain to the latest possible moment, to be then removed by means of a douche of cold water. By this method a varicocele of small or moderate size may be so braced up as to render it for a time hardly noticeable.

The Operative Treatment

In the operative treatment, i.e. the so-called 'radical cure' of varicocele, the essential object to be attained is the complete obliteration of the veins, either by ligature, section, or the production by some means of thrombus of a kind which is likely to lead to permanent blocking.

To this main object may be added (1) the partial extirpation of the disease by excising a portion of the abnormal vessels, and (2) the direct shortening of the cord by the removal, not only of a portion of the veins themselves, but also a corresponding part of

the sheath in which the varicocele lies, as is done in the operation which I practise and strongly advocate.

The cases to which the radical treatment is applicable are of two kinds, viz., those in which it is *expedient*, and those in which it is *necessary*.

1. Cases in which operation is expedient:

(*a*) Cases in which candidates have been actually rejected, or have reason to anticipate rejection for the public services on account of 'physical defect.'

(*b*) Cases in which the mere size of the affection is sufficient to lead to risk of injury, or in any other way causes enough inconvenience to the patient to induce him to seek relief.

(*c*) Cases of double varicocele in which there is reason to suspect material impairment of testicular function, the treatment being undertaken for the purpose of allowing the development of the proper physiological activity of the affected organs.

(*d*) In the 'radical cure' of hernia or hydrocele, if a varicocele also exists, it may be desirable to take the opportunity of dealing with it at the same time. Under these circumstances, some difference of opinion may naturally be expected as to the propriety of the treatment. Personally, I am sure it is better to operate on the varicocele. It has only occurred to me on one occasion to find a varicocele whilst performing the radical cure for hernia, and in that case there

was no doubt as to the propriety of operating on the veins, as the 'radical cure' of the hernia was performed with a view to making the patient eligible for the army.

(*e*) Certain cases of mental anxiety.

The kind of patient affected in this way is sufficiently described on page 15, and, as there stated, operation as a rule fails to effect much good. At the same time, if the patient is obviously hypochondriacal, not broken down mentally, and has a great inclination and faith in an operation, whilst all other treatment has failed to give any comfort, I believe the radical cure may be with perfect propriety recommended. It *may* give the sufferer the relief he seeks, and being, as I believe, entirely free from risk, if it fails no great harm is done. Two important practical points must, however, be here insisted upon. (1) The operation should be of such a kind that some immediate change in the varicocele is produced, otherwise the patient will not be mentally satisfied with the result. (2) *On no account should a second operation be performed if the first fails to effect the purpose desired*, for under those circumstances failure is certain also to follow the second attempt. Cases of this kind are known to have occurred, if they have not been actually recorded, in which a patient, having been operated upon by one surgeon without success, has induced some other practitioner

to repeat the operation, and relief being again not obtained has then been castrated without the least ultimate benefit. It is clear, therefore, that the recommendation of the 'radical cure' in patients of this class, although proper in some instances, is a matter requiring mature consideration and great discretion.

2. Symptoms which may render operation necessary.

(*a*) Pain, whether continuous or intermittent, which yields neither to general management nor medical treatment.

(*b*) Tenderness, general or local, not caused by recent thrombus or inflammation of surrounding parts, and uninfluenced by other treatment.

(*c*) Rapid increase in size, independent of obvious causes outside the disease itself, such as the pressure of abdominal tumours.

(*d*) Certain conditions of sexual irritation which have been fully described.

3. The following conditions (apart from such as would negative generally any surgical proceeding) render the operative treatment of varicocele as such entirely unjustifiable.

(*a*) Co-existence of abdominal tumour.

(*b*) Organic disease, or persistent engorgement, of the liver.

(*c*) Heart disease.

(*d*) Recent thrombus.

(*e*) Inflammation in immediate neighbourhood, e.g. epididymitis.

(*f*) Disease of testicle.

(*g*) Advanced hypochondriasis, monomania, melancholia, or other evidence of mental insufficiency.

Operations Available

In considering the several operations which may at present be thought appropriate for the radical treatment of varicocele, I do not propose to give any historical account of the various methods used in ancient or moderately remote times, as this has been already so well done by others, and also because by so doing my present purpose in affording the results of my own experience would not be furthered.

I intend, on the other hand, to confine my remarks to those proceedings of which I have personal knowledge obtained in the course of an experience which does not extend farther back, in any useful form, than the commencement of the antiseptic era of surgery, using the term 'antiseptic' as identical in meaning with surgical 'cleanliness' properly so-called.

For practical purposes, the operations at present employed for effecting the so-called 'radical cure' of varicocele may be divided into two distinct classes, viz., the subcutaneous method by which obliteration

of the veins is attempted without exposing either the vessels themselves or the parts immediately around, and the open operation by which the veins or the surrounding parts are first formally exposed by dissection, and then dealt with in a variety of ways to be subsequently described.

The Subcutaneous Method

The 'subcutaneous' operations consist mainly of two kinds, in one of which it is sought to effect the occlusion of the veins by the passage of a ligature or ligatures around them, beneath the skin, by means of an ordinary needle, or by some instrument, such as that of Keyes, especially designed for the purpose, but which can hardly be really necessary in the hands of a competent operator. The ligatures may be of silk, tendon, catgut, metal, or elastic, and may be left buried in the soft parts to remain permanently, or in the case of catgut with a view to early absorption. If the metallic or elastic ligature be used, it may be so arranged in either case as to cut its way out, thus ensuring the complete obliteration of the veins included.

In the second variety of the 'subcutaneous' method the obliteration of the veins is more certainly attained by the division of the varicocele with a thin knife (phlebotome) introduced through a small opening in the skin, the veins having been previously

ligatured or temporarily compressed between a hare-lip pin and figure-of-8 ligature, or some similar arrangement, above and below the point at which the division is subsequently made. Upon the details of these subcutaneous proceedings it is not my intention to dwell; for, although they are still practised by some surgeons, I have long since come to the conclusion that they are in all respects inferior to the open operation.

I do not, of course, wish it to be inferred that I think that varicocele may not in some cases, especially those in which the disease is slight, be cured by the subcutaneous plan.

The method is, however, open to objection chiefly on two accounts: the first of which is the uncertainty of its results; the second is the occasional risk, entirely beyond the control of the surgeon, which occurs in the performance of the operation.

The uncertainty in the result, to which may be attributed a considerable percentage of cases in which recurrence of the disease occurs, is due to the great difficulty which sometimes presents itself in including with absolute certainty in the ligature all the affected veins, a proceeding in my opinion positively essential for the cure of the disease, for it is necessary to bear in mind that the veins are not disposed with invariable uniformity, but that there are often small radicles lying outside the general

mass, which if not included in the ligatures will almost certainly lead to recurrence.

Again, in those cases in which the cure is attempted by the division of the veins subcutaneously between two temporary ligatures, it is admitted to be by no means easy to be sure that all the veins have been divided, and it is here again manifest that if any veins escaped the knife a recurrence of the affection would be more than probable.

The risk to which I have referred as being more particularly connected with the subcutaneous operation is the possibility of one or more veins being transfixed in the process of encircling the varicocele with a ligature. This accident, which in an irregular disposition of veins may occur to the most expert of operators, may not necessarily be of importance; nevertheless, it does at times lead to disastrous consequences, as I have seen in one case, although fortunately it did not occur in my own practice.

Speaking generally of the subcutaneous plan, it seems to me that in the present condition of surgery there is a singular anomaly in performing under cover of the skin, that is to say, out of sight, and, therefore, necessarily wanting in exactness and certainty, an operation which by the open method may be carried out with absolute precision, with what I believe to be no unavoidable risk, and with greater certainty in result.

In former times, when the ordinary operations for varicocele were universally so disastrous, either from the nature of the proceedings themselves, or from the septic conditions under which they were practised, the subcutaneous plan was so comparatively free from inflammation, suppuration, and decomposition, with their attendant evils, that its introduction was an incalculable boon; but now, when the occurrence of either suppuration or decomposition is rarely the result of anything but misfortune or bad management in this class of operation, there can hardly be any good reason for retaining the subcutaneous method which, with its uncertainty and unseen risk, should be allowed to become obsolete.

The Open Operation

From what has just been said, it will be seen that the 'open' method compares favourably, in my opinion, with the 'subcutaneous' plan of treatment. It is simple in practice, certain in result, and in the hands of any surgeon who is reasonably attentive to detail, and who observes ordinary precautions of surgical cleanliness, there is, I believe, directly connected with the operation no risk of any kind which is not avoidable.

As has been already mentioned, the essential part of the open method is the formal exposure by

dissection of the portion of the varicocele about to be subjected to operation. The obliteration of the veins thus exposed is then ordinarily accomplished by one of the following procedures:

1. The encircling of the veins by a single ligature.

2. The complete division of the veins between two ligatures.

3. The excision, *en masse*, of a portion of the varicocele previously included between two ligatures.

Of these operations, Nos. 1 and 2 may be considered together. By the performance of either, it is, without doubt, possible to secure the complete obliteration of the affected veins at the point of ligature. I have, however, met with one case in my own practice in which there was speedy recurrence of the variocele after the application of the single ligature. The result was, I suppose, due to the ligature, which was of chromic gut, having dissolved before the sealing of the veins at the point of ligation was completed, and may be easily avoided by the use of a more resisting structure for securing the veins. Tendon is probably the best material available for this purpose. It can, however, hardly be doubted that the complete division of the varicocele between two ligatures, as is done in the operation No. 2, affords an additional means for the avoidance of failure in effecting the permanent occlusion of the vessels.

Either of these proceedings is admirably adapted for the treatment of varicoceles in which the veins are small, and the cord only very slightly elongated. Both, however, are wanting in a factor which, in my judgment, is essential to any operation for the immediate cure of cases in which the veins are long and large and the testis greatly dependent. Operation No. 3 does to a certain degree meet the requirement to which I have referred as being absent in Nos. 1 and 2, since the excision of a considerable portion of the varicocele between ligatures results in some shortening of the elongated cord *if the testis is effectually supported for a long period*, but this shortening is only produced by the contraction of the material effused about the divided parts, and, be it noted, is, so far as the intention of the surgeon is concerned, to a great extent accidental, for I can find no record of the operation having been carried out deliberately for this especial purpose; indeed, if it be so performed, the result must necessarily be indirect and very gradual, its ultimate success depending entirely upon long-continued support from suspenders or some similar arrangement. The only recorded operation resulting in anything like direct shortening of the cord, is one introduced by Mr. Henry Lee, to which reference will again be made.

This brings me to the point to which I particularly wish to call attention. In my opinion, no

operation for the cure of these long varicoceles is perfect unless it includes some proceeding planned deliberately for attaining an immediate and permanent shortening of the cord, *with the object of relieving the patient from the necessity of wearing some form of external support for a long period, as well as ensuring an immediate freedom from the discomfort of the dependent testis, which is not only inconvenient in itself, but tends to the recurrence of various symptoms, unless the support of a proper suspender be continually afforded.* With the object of deliberately effecting this direct result, I have been for some years in the habit of performing the operation described below, to which I first drew attention in the 'Lancet' of February, 1889; it may be adopted, not only in cases of great elongation of the cord, but in most instances in which the abnormally low position of the testis is at all marked; in fact, whenever shortening of the cord is likely to be beneficial. In severity, the proceeding is exactly on a par with the ordinary open operations, but convalescence is more rapid, and the ultimate result undoubtedly better.

The precise extent of the varicocele which it is desirable to resect in any given case, is best determined by placing the patient in the standing position, and roughly estimating with the eye, or, better still, by measuring with a tape, the degree of elongation of the cord: for instance, should the testis be three

inches lower than normal, then certainly not less than three inches of the veins should be included between the two ligatures, as it will be desirable to excise at least two inches and a half.

Details of the Operation for the 'Radical Cure' of Varicocele by the Excision of a Portion of the Veins and Immediate Shortening of the Cord.

The patient having been anæsthetised, the veins are made prominent and put somewhat on the stretch by grasping the varicocele between the fingers and thumb of the left hand, care being taken at the same time that the vas deferens is pressed back out of the way of harm. Through the skin, over the veins thus rendered prominent, an incision is made which in no case need exceed an inch in length. One or two touches of the scalpel will now suffice, the veins being pressed well forwards to expose the thin fascia (immediately surrounding the varicocele), through which the vessels can be clearly seen. The knife is now laid aside, the veins not having been actually *denuded*. By means of an aneurysm needle or eyed probe a thoroughly carbolised tendon is passed round the fascia referred to, with its included veins, and drawn down to a point as near the testis as is thought proper; it is then securely tied, the ends being left long. The varicocele above this

ligature is then freed, together with its sheath, from the surrounding parts by a few sweeps of the finger for a distance sufficient to allow of the length previously decided upon in the manner I have indicated above, as appropriate for excision to be drawn out of the wound. A second tendon is now passed around the upper end of the freed veins as near the external abdominal ring as practicable and tied in *single knot* only, which is kept tight by an assistant. The portion of the varicocele included between the ligatures is divided above and below, about a quarter of an inch (not less) from the corresponding ligature, and removed. The upper ligature is then finally tightened and its knotting completed, the ends being left long as before. The wound having been freely irrigated with warm sublimate solution and all bleeding (be it ever so slight) arrested, one of the ends of the ligature above and below is threaded on a needle, and passed through the corresponding stump between the cut end and the ligature in the manner shown in the diagram.

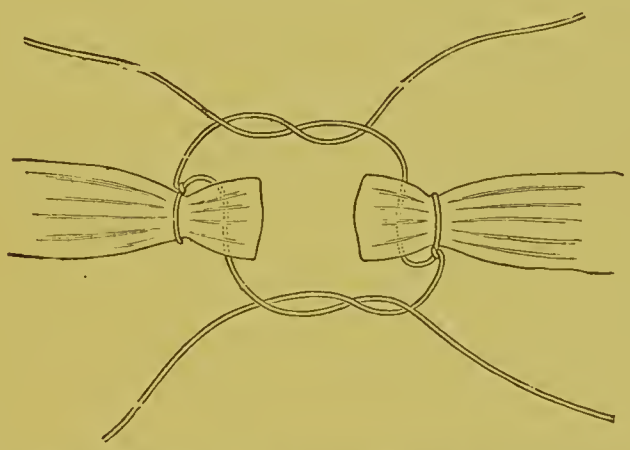
The stumps are then brought together and kept accurately in contact by knotting the ends of the upper ligature to those of the lower.[1]

Finally, the ligature ends are cut short and the operation is completed. The edges of the skin fall

[1] If preferred the ligature ends may be cut short, and the parts brought together by means of a carbolised suture passing through the stumps between their cut edges and the ligatures.

together, there is no need for either suture or drainage tube, and all that remains necessary is the careful application of the antiseptic dressing.

The postponement of the final tightening and knotting of the upper ligature *until after the division of the veins* is a point of importance, as there is some risk, if the tying be completed before the division, that the shrinking of the veins which follows the escape of blood contained in them may result in the



Showing method of approximating the stumps.

ligature becoming sufficiently loose to allow of an oozing of blood into the wound, and indeed may possibly, as I have once seen, permit the stump to escape from the ligature altogether, in which case the primary object of this particular operation would be defeated. Every care must be taken to avoid any possibility of oozing into the parts around the stumps, as the formation of a clot in the wound delays the healing, and greatly prolongs the convalescence.

It is hardly needful to state that all manipulation of the veins must be confined to the parts lying between the two ligatures, as any injury to the vessels beyond the constricted points, whether above or below, introduces an element of risk. If the details of this procedure, as described above, are carefully carried out, the subsequent course of the case is simple and uninterrupted. In four or five days the wound has, as a rule, healed, and the approximated stumps are surrounded by a mass of callus. At the end of a week the patient may usually be allowed out of bed, and although the swelling about the cord does not entirely disappear for perhaps a month, any ordinary occupation may be resumed in fourteen days or thereabouts. Upon the absorption of the callus nothing abnormal is perceptible to the touch but a very slight circumscribed hardness, which remains permanent around the ligature knots. A suspender is worn up to the time of the disappearance of the swelling, and then finally discarded, leaving the testis well braced up in its natural position, with the scrotum accurately adapted to it, no matter how long and flabby that structure may have previously been. Little or no pain follows the operation, but during the first fortnight there may be some œdema of the scrotum, and the testis is generally slightly tender. I have seen no real orchitis, nor has there been, in my cases, suppuration about the wound, or any constitutional

disturbance. I am not acquainted with another method so rapidly producing a 'cure,' which may fairly be called 'radical.'

By leaving the sheath of fascia which immediately surrounds the varicocele intact, and including it with the veins in the ligature, two objects are attained: (1) the certainty of passing the tendon around all the affected vessels, as none of these ever lie outside the fascia; and (2) the prevention of any material chance of recurrence of the abnormally dependent position of the testicle, which is probable *if the veins are actually denuded before the ligatures are applied* and the stumps brought together in the manner described, since it is manifest that the weight of the testis would tend to drag the veins considerably out from the sheath above; whereas this fascia, if included in the ligatures, not only obviates this tendency, but, in fact, also carries the weight of the dependent organ without stretching to any appreciable extent, thus rendering the use of a suspender entirely unnecessary after the approximated stumps have fairly united.

Although at first I employed this operation for very long varicoceles only, I have, during the last two years, used it in every case, irrespective of size, upon which I have operated, even in those which were too small to actually require the excision of any portion of the cord.

The free division of the veins between the ligatures allows any small vein which may by chance lie outside the portion of fascia included to be detected, and tied with a fine piece of carbolised catgut, thus ensuring greater certainty in the ultimate result; and the re-union of the stumps prevents in the first place the dropping of the testis, which otherwise occurs when the veins are divided freely, and subsequently obviates, as has been already pointed out, the necessity for wearing a suspender, which many patients regard as a nuisance.

The Effect of the Radical Treatment of Varicocele upon the Nutrition of the Testicle

It has been abundantly proved that in cases of varicocele associated with defective development of the testis, the operation for the so-called radical cure is followed by improvement in the condition of the organ, as indicated by its attaining a condition of natural tone and consistence, and, in some instances, it has been shown to have become physiologically more perfect than before. Nevertheless there exists in the minds of some people a belief that risk of atrophy of the testicle is incurred by this radical treatment, especially if the spermatic artery should chance to be severed with the veins.

This belief presumably owes its existence to the records of cases of shrinking of the testicle after ope-

ration, which undoubtedly occurred not unfrequently in former times.

Now in the operation just described, which I invariably employ, it will be seen that the whole of the spermatic plexus of veins, with the exception occasionally of a small vessel lying remotely at the back, are contained within the sheath formed by the fascia, around which the ligatures are passed, one object of including the sheath in the ligature being to ensure the obliteration of the whole of the veins; for it is clear that if the ligatures are passed round this connective tissue sheath before the vessels are exposed none of them can escape. Further, if the ligatures are passed in the manner indicated, not only are the veins with certainty included, but also the main trunk of the spermatic artery, in evidence of which it is my custom, when operating in hospital practice, to demonstrate the existence of a section of this artery in the excised portion of the cord. Two points of interest here arise: First, it is obvious that if the spermatic artery is included in the ligature, as it certainly is under these circumstances, the traditional teaching of the schools, that the vas deferens when pushed aside carries the spermatic artery with it, is wrong.

Practically this is so, for the artery does not go with the vas deferens when it is displaced, but remains either quite close to the spermatic veins, or, as com-

monly happens in varicocele, is actually surrounded by them. So intimate, indeed, is this relation of the artery to the veins that I believe it to be almost impossible to include the whole of the latter vessels *en masse* in a ligature in a case of varicocele without also including the artery, unless an elaborate and tedious dissection be undertaken for the purpose.

I have, therefore, little doubt that in the vast majority of operations for varicocele, in which the spermatic plexus of veins is divided, the main trunk of the artery is also involved in the section.

It is difficult to see upon what anatomical basis this traditional view as to the associated displacement of the vas deferens and spermatic artery rests. It is, however, possible that the belief commonly held that the nutrition of the testicle is dependent almost entirely upon the integrity of the spermatic artery led to the conclusion that in operations in which the spermatic veins were freely divided the artery had escaped injury because no ill effect was necessarily produced upon the testicle. It was then easy to assume that the apparent safety of the vessel was due to its having been pushed aside with the vas deferens.

The second point of interest is the effect of this division of the spermatic artery, together with the veins, upon the nutrition of the testicle. The isolated position of this organ, coupled with the accepted view

just referred to, that its blood-supply depends almost entirely upon the long and slender spermatic artery, has given rise to the impression, which is entirely wrong, that its vitality is endangered by the division of this vessel, together with the spermatic plexus of veins.

In division of the spermatic artery with the veins no harm whatever should result, for the artery of the vas deferens which is certain to have escaped injury is by no means always an insignificant vessel, and generally sufficient by its anastomoses with the spermatic to prevent not only immediate necrosis of the testicle, but also subsequent wasting, as it receives assistance from other vessels which will be indicated presently. In support of this contention I can state without any hesitation that in almost every case of varicocele upon which I have, during the past three years, operated, a portion of the spermatic artery could be demonstrated in the excised part of the cord, and that in none of these instances has there been the least suspicion of wasting. On the contrary, the testicle, when soft or small, has invariably become more natural in size and consistence, and certainly in one instance more perfect in a physiological sense. In fact, the vitality of the testicle is much greater than is commonly supposed, for neither sloughing nor immediate wasting necessarily follows even if the whole cord, including

the vas deferens, be divided as I have shown in a communication in the 'Lancet' of March 7, 1891, from which my present remarks are taken.

In the pre-antiseptic period of surgery there is little doubt that any extensive injury to the cord was liable to be followed by wasting or sloughing of the testicle. Hence the traditional teaching to that effect. The only possible explanation of the survival of the organ, after such a serious interference with its vascular arrangement as the division of the spermatic artery and veins, must lie in the fact that there exists a considerable arterial supply over and above that which need be involved in a section of the cord itself. The sources of this additional blood-supply are (1) some outlying branches of the spermatic artery, one of which sometimes comes off high up, and so may easily escape division; (2) the artery of the vas deferens, which is not injured; and (3) some small but important anastomotic vessels passing from the subvaginal tissue. This additional supply, although sufficient under favourable circumstances to maintain adequate nutrition of the testicle, is, however, derived from vessels some of which are small and delicate; *any inflammation, therefore, about the part may be sufficient to choke them*, sloughing or wasting of the organ following as a necessary result. If, however, no inflammation occurs — i.e. if the wound remains aseptic — the supply of blood

is enough to prevent sloughing or subsequent atrophy.

The immediate cause, then, of the necrosis or shrinking of the testicle, which happened in these cases in the days prior to the practice of surgical cleanliness, as the term is now interpreted, appears to me to have been not the mere division of the cord, but rather the inflammation and suppuration, one or both of which so frequently followed upon it.

The principal points to which I wish to call attention in connection with this matter may be conveniently summed up in the following conclusions, which, although in several respects opposed to what is commonly taught, I believe from experience to be perfectly sound :—(1) That the vas deferens, having been displaced in the manner usually adopted in operations for varicocele, the spermatic artery does not accompany it, but remains with the spermatic veins. (2) That in cases of varicocele the division of the main trunk of the spermatic artery, together with the veins, if the ordinary principles of surgical cleanliness be observed, is not only harmless to the testicle, but aids in the ultimate relief of the affection by diminishing the pressure of blood going to the testis at the time when almost all the returning veins are suddenly obliterated.

Causes of Recurrence after the Operation for the Radical Cure

If the operation for the radical relief of varicocele is effectually performed, recurrence in the proper sense is virtually impossible.

The factors tending to recurrence are three in number :—

1. *Failure to include the whole spermatic plexus of veins in the ligature.*—This is by far the most fruitful cause, and ought never to occur excepting in cases treated by the subcutaneous plan, as in the open operation the obliteration of all the veins can be made absolutely certain by dividing them between two ligatures.

The following cases afford good illustrations of recurrence from this cause :—

(*a*) A youth, twenty years of age, suffering from varicocele, had been operated upon by the subcutaneous method, the veins having been divided by a wire which had been made to gradually cut its way out. Upon getting about again, three weeks after the operation, the affection rapidly became as bad as before the treatment. Subsequently, I operated in my usual manner, excising the portion of the cord involved in the previous operation. It was found, upon examining the excised part, that only about half of the veins were occluded. The remainder,

which had clearly not been surrounded by the wire, were very large and fully sufficient to account for the complete failure of the treatment.

(*b*) A patient was admitted into St. George's Hospital, under my care, who had been subjected to operation for varicocele in another London hospital, as he had been rejected for the navy. The operation was perfectly futile, for no visible change of any kind was produced in the condition, and he was almost immediately again rejected. When I saw him there was a large pendulous varicocele in the centre of which was a small nodule, evidently the consolidation about the ligature. In this case, also, I excised a large extent of the varicocele, including the seat of the previous operation. It was found that not more than one-third or thereabouts of the plexus had been included in the ligature, hence the complete failure of the first treatment.

2. *The seat of the operation may be too low.*—In cases in which all the veins and, as I believe is then generally the case, the spermatic artery also is included in the operation, it is clear that the portion of the varicocele below the seat of operation must of necessity be obliterated. If, however, the upper ligature be applied too low down the part of the varicocele between it and the external abdominal ring remains full, giving a distinct impulse on coughing and causing some discomfort to the

patient during exertion, for some time after the treatment.

Although this is, of course, no *recurrence* in the real meaning of the word, the condition is liable to be considered as such by the patient.

In these cases it is true that, unless the upper ligature has been placed very low down indeed, the 'uncured' piece of varicocele above gradually shrinks. Nevertheless, it is far more radical and satisfactory to place the upper ligature, as I always do, as near the external ring as practicable, the lower one being applied as far below as the circumstances of the case require. If the intervening portion of the varicocele is then excised, recurrence real or apparent is for practical purposes impossible.

3. *Insecure knotting of the ligature may lead to its giving way directly after the operation, or the material used may be of a kind liable to be absorbed before the veins had been compressed sufficiently long to cause permanent occlusion.*—Under either of these conditions, if the ligature without division of the veins is employed, the lumen of some or all of the vessels may be re-established, and recurrence thus brought about.

The following case is, I believe, an instance of recurrence from too early absorption of the ligature, which occurred in my own practice before I gave up using the ligature only, without division of the veins.

The patient was a lad with a large varicocele

which I freely exposed by dissection, and without doubt included the whole of the veins in a single small carbolised catgut ligature. The case apparently did well, but at the end of a week after the operation, when the patient began to get about, the varicocele rapidly assumed its ordinary condition, and in three or four days no evidence whatever of the performance of any operation remained with the exception of the scar in the scrotum. It is naturally possible that the knot of the ligature in this case was insecurely tied and became unfastened, but I do not think this was the cause of the recurrence, as the catgut was tied with great care.

The consequences of too early absorption may b avoided by using a ligature of a more resistent nature, e.g. tendon and, better still, by the uniform practice of division of the veins between two ligatures, which puts failure from this cause out of the question.

The Operation of Shortening the Scrotum as a means for the Relief of Varicocele

With a view to correcting the abnormally dependent position of the testis in varicocele, by the provision of a natural suspender, the operation of shortening the scrotum by excising a portion of the skin and dartos, was at one time extensively practised. It has now very properly fallen into disuse in this country, but is still to some extent used on the

Continent and in America. Indeed, special instruments of clamp-like form have been comparatively recently invented to facilitate its performance, although the necessity for a special apparatus for the effective carrying out of such a very simple proceeding is not quite apparent.

This operation is useless in practice and unsound in theory, as it is based on an entire misapprehension of the functional relation of the scrotum to the testis. To whatever extent the scrotum may be diminished in size by removing portions of skin and dartos, it will again become stretched until it has acquired a length which will be solely determined by the lowest point reached by the testicle as it hangs at the end of the cord.

On the other hand, if the testicle is raised by shortening the cord, the scrotum, be it ever so long and flaccid, will spontaneously contract, and accurately adapt itself to the testicle in its new position.

Personally, therefore, I do not consider that any permanent advantage whatever can be derived from shortening the scrotum, even supposing that the operation employed is of a much more radical nature than the one just referred to.

Under no circumstances is it possible to shorten the scrotum for any considerable period excepting by a much more extensive operation than the removal of a portion of the skin and immediately

subjacent tissue; in fact, in order to produce such a result the whole thickness of the scrotal wall must be removed.

Further, it is perfectly certain that this proceeding will be also transient in result unless the varicocele is shortened at the same time; for, although the scrotum when diminished by the excision of a part of its whole thickness elongates again less quickly than when the skin only has been removed, its stretching to a degree which will be determined by the length of the cord is merely a question of time. The only recorded operation which can be considered to achieve in any way the immediate shortening of the cord and scrotum conjointly, is that introduced by Mr. Henry Lee about the year 1860. In this 'needles were introduced' (beneath the veins and through the scrotal walls) 'as far apart as 'possible, and after the veins were secured by the '"8"-ligature passed over the ends of the needles, 'the intermediate portion of the skin, together with 'the subjacent tissues containing the enlarged veins, 'was removed, leaving a very considerable gap. The 'needles were then drawn towards each other, and 'by this means the edges of the wound were brought 'together and maintained in position.'[1]

I have employed this operation in the manner described by Mr. Henry Lee, and also modified as

[1] *Practical Pathology*, p. 101.

follows:—the veins were first treated in the way I have recommended for the immediate shortening of the cord, and then the scrotum diminished in size as much as possible by removing a very large wedge-shaped piece of the whole thickness of the corresponding side of the scrotal walls, the edges of the wound being brought together with carbolised catgut sutures. Careful 'antiseptic' precautions were of course taken throughout. These cases did well, but the removal of large portions of the scrotum made the proceeding more serious than the method I advocate, and the convalescence was more protracted.

One of the patients was seen rather more than a year subsequently; the scrotum had elongated again to some extent, that is to say, as far as the testis required it to stretch, and was neither shorter nor more supporting than in another case of precisely the same severity, operated upon about the same date, in which no portion of the scrotum had been removed.

I am, therefore, quite convinced that the excision of portions of the scrotal walls is superfluous in these cases, and productive of no real good, whilst at the same time it increases the severity of the treatment, and prolongs the convalescence.

I would, indeed, go farther and say that this operation is objectionable, since the extensive in-

terference with the whole thickness of the scrotal tissues impedes the proper action of the cremaster, and thus to some degree deprives the testicle of its living sling, a matter of much more importance for the comfort of the patient than is commonly supposed.

In one of these cases, for instance, seen about nine months after the operation, the action of the cremaster caused merely a tucking-in of the scrotal scar, instead of freely raising the testicle in the natural way, illustrating practically the point just alluded to.

The scrotum, as I have already said, will, of its own accord, contract exactly to the required degree if the testicle is raised by shortening the cord.

For those surgeons, however, who believe in the advantage or efficacy of removing large portions of the scrotum, there is no doubt whatever that this combined operation, by which both the cord and scrotum are shortened at the same time, is the only method based upon anything like practical grounds.

PRINTED BY
SPOTTISWOODE AND CO., NEW-STREET SQUARE
LONDON

A LIST OF WORKS ON

MEDICINE, SURGERY

AND

GENERAL SCIENCE,

PUBLISHED BY

LONGMANS, GREEN & CO.,

39, PATERNOSTER ROW, LONDON.

Medical and Surgical Works.

ASHBY. NOTES ON PHYSIOLOGY FOR THE USE OF STUDENTS PREPARING FOR EXAMINATION. By HENRY ASHBY, M.D. Lond., F.R.C.P., Physician to the General Hospital for Sick Children, Manchester; formerly Demonstrator of Physiology, Liverpool School of Medicine. Fifth Edition, thoroughly revised. With 134 Illustrations. Fcap. 8vo, price 5*s.*

ASHBY AND WRIGHT. THE DISEASES OF CHILDREN, MEDICAL AND SURGICAL. By HENRY ASHBY, M.D. Lond., F.R.C.P., Physician to the General Hospital for Sick Children, Manchester; Lecturer and Examiner in Diseases of Children in the Victoria University; and G. A. WRIGHT, B.A., M.B. Oxon., F.R.C.S. Eng., Assistant Surgeon to the Manchester Royal Infirmary and Surgeon to the Children's Hospital. With 138 Illustrations. 8vo, price 21*s.*

BARKER. A SHORT MANUAL OF SURGICAL OPERATIONS, HAVING SPECIAL REFERENCE TO MANY OF THE NEWER PROCEDURES. By ARTHUR E. J. BARKER, F.R.C.S., Surgeon to University College Hospital, Teacher of Practical Surgery at University College, Professor of Surgery and Pathology at the Royal College of Surgeons of England. With 61 Woodcuts in the Text. Crown 8vo, price 12*s.* 6*d.*

BENNETT. CLINICAL LECTURES ON VARICOSE VEINS OF THE LOWER EXTREMITIES. By WILLIAM H. BENNETT, F.R.C.S., Surgeon to St. George's Hospital; Member of the Board of Examiners, Royal College of Surgeons of England. With 3 Plates. 8vo. 6*s.*

BENTLEY. A TEXT-BOOK OF ORGANIC MATERIA MEDICA. Comprising a Description of the Vegetable and Animal Drugs of the British Pharmacopœia, with some others in common use. Arranged Systematically and Especially Designed for Students. By ROBERT BENTLEY, M.R.C.S. Eng., F.L.S., Fellow of King's College, London; Honorary Member of the Pharmaceutical Society of Great Britain, &c. &c.; one of the three Editors of the "British Pharmacopœia," 1885. With 62 Illustrations on Wood. Crown 8vo, price 7*s.* 6*d.*

COATS. A MANUAL OF PATHOLOGY. By JOSEPH COATS, M.D., Pathologist to the Western Infirmary and the Sick Children's Hospital, Glasgow; Lecturer on Pathology in the Western Infirmary; Examiner in Pathology in the University of Glasgow; formerly Pathologist to the Royal Infirmary, and President of the Pathological and Clinical Society of Glasgow. Second Edition. Revised and mostly Re-written. With 364 Illustrations. 8vo, price 31*s.* 6*d.*

COOKE.—*WORKS by THOMAS COOKE, F.R.C.S. Eng., B.A., B.Sc., M.D Paris, Senior Assistant Surgeon to the Westminster Hospital, and Lecturer at the School of Anatomy, Physiology, and Surgery.*

TABLETS OF ANATOMY. Being a Synopsis of Demonstrations given in the Westminster Hospital Medical School in the years 1871–75. Eighth Thousand, being a selection of the Tablets believed to be most useful to Students generally. Post 4to, price 7*s.* 6*d.*

APHORISMS IN APPLIED ANATOMY AND OPERATIVE SURGERY. Including 100 Typical *vivâ voce* Questions on Surface Marking, &c. Crown 8vo, 3*s.* 6*d.*

DICKINSON.—*WORKS by W. HOWSHIP DICKINSON, M.D. Cantab., F.R.C.P., Physician to, and Lecturer on Medicine at, St. George's Hospital; Consulting Physician to the Hospital for Sick Children; Corresponding Member of the Academy of Medicine of New York.*

ON RENAL AND URINARY AFFECTIONS. Complete in Three Parts, 8vo, with 12 Plates and 122 Woodcuts. Price £3 4*s.* 6*d.* cloth.

*** The Parts can also be had separately, each complete in itself, as follows:—

PART I.—*Diabetes*, price 10*s.* 6*d.* sewed, 12*s.* cloth.
,, II.—*Albuminuria*, price £1 sewed, £1 1*s.* cloth.
,, III.—*Miscellaneous Affections of the Kidneys and Urine*, price £1 10*s.* sewed, £1 11*s.* 6*d.* cloth.

THE TONGUE AS AN INDICATION OF DISEASE; being the Lumleian Lectures delivered at the Royal College of Physicians in March, 1888. 8vo, price 7*s.* 6*d.*

ERICHSEN.—*WORKS by JOHN ERIC ERICHSEN, F.R.S., LL.D.* (*Edin.*), *Hon. M. Ch. and F.R.C.S.* (*Ireland*), *Surgeon Extraordinary to H.M. the Queen; President of University College, London; Fellow and Ex-President of the Royal College of Surgeons of England; Emeritus Professor of Surgery in University College; Consulting-Surgeon to University College Hospital, and to many other Medical Charities.*

THE SCIENCE AND ART OF SURGERY; A TREATISE ON SURGICAL INJURIES, DISEASES, AND OPERATIONS. The Ninth Edition, Edited by Professor BECK, M.S. & M.B. (Lond.), F.R.C.S., Surgeon to University College Hospital, &c. Illustrated by 1025 Engravings on Wood. 2 Vols. 8vo, price 48*s.*

ON CONCUSSION OF THE SPINE, NERVOUS SHOCKS, and other Obscure Injuries of the Nervous System in their Clinical and Medico-Legal Aspects. New and Revised Edition. Crown 8vo, 10*s.* 6*d.*

GAIRDNER AND COATS. ON THE DISEASES CLASSIFIED by the REGISTRAR-GENERAL as TABES MESENTERICA. LECTURES TO PRACTITIONERS. By W. T. GAIRDNER, M.D., LL.D. On the PATHOLOGY of PHTHISIS PULMONALIS. By JOSEPH COATS, M.D. With 28 Illustrations. 8vo, price 12*s.* 6*d.*

GARROD.—*WORKS by Sir ALFRED BARING GARROD, M.D., F.R.S., &c.; Physician Extraordinary to H.M. the Queen; Consulting Physician to King's College Hospital; late Vice-President of the Royal College of Physicians.*

A TREATISE ON GOUT AND RHEUMATIC GOUT (RHEUMATOID ARTHRITIS). Third Edition, thoroughly revised and enlarged; with 6 Plates, comprising 21 Figures (14 Coloured), and 27 Illustrations engraved on Wood. 8vo, price 21*s.*

THE ESSENTIALS OF MATERIA MEDICA AND THERAPEUTICS. The Thirteenth Edition, revised and edited, under the supervision of the Author, by NESTOR TIRARD, M.D. Lond., F.R.C.P., Professor of Materia Medica and Therapeutics in King's College, London, &c. Crown 8vo, price 12*s.* 6*d.*

GARROD. AN INTRODUCTION TO THE USE OF THE LARYNGOSCOPE. By ARCHIBALD G. GARROD, M.A., M.B. Oxon., M.R.C.P. With Illustrations. 8vo, price 3*s.* 6*d.*

GRAY. ANATOMY, DESCRIPTIVE AND SURGICAL. By HENRY GRAY, F.R.S., late Lecturer on Anatomy at St. George's Hospital. The Twelfth Edition, re-edited by T. PICKERING PICK, Surgeon to St. George's Hospital; Member of the Court of Examiners, Royal College of Surgeons of England. With 615 large Woodcut Illustrations, a large proportion of which are Coloured, the Arteries being coloured red, the Veins blue, and the Nerves yellow. The attachments of the muscles to the bones, in the section on Osteology, are also shown in coloured outline. Royal 8vo, price 36*s.*

HALLIBURTON. A TEXT-BOOK OF CHEMICAL PHYSIOLOGY AND PATHOLOGY. By W. D. HALLIBURTON, M.D., B.Sc., M.R.C.P., Professor of Physiology at King's College, London; Lecturer on Physiology at the London School of Medicine for Women; late Assistant Professor of Physiology at University College, London. With 104 Illustrations. 8vo, 28*s.*

HASSALL.—*WORKS by ARTHUR HILL HASSALL, M.D. London.*

SAN REMO CLIMATICALLY AND MEDICALLY CONSIDERED. New Edition, with 30 Illustrations. Crown 8vo, price 5*s.*

THE INHALATION TREATMENT OF DISEASES OF THE ORGANS OF RESPIRATION, INCLUDING CONSUMPTION. With numerous Illustrations. Crown 8vo, price 12*s.* 6*d.*

HERON. EVIDENCES OF THE COMMUNICABILITY OF CONSUMPTION. By G. A. HERON, M.D. (Glas.), F.R.C.P., Physician to the City of London Hospital for Diseases of the Chest. 8vo, 7*s.* 6*d.*

HEWITT.—*WORKS by GRAILY HEWITT, M.D. Lond., F.R.C.P., F.R.S. Ed., Emeritus Professor of Obstetric Medicine, University College; Consulting Obstetric Physician to University College Hospital, &c., &c,*

ON SEVERE VOMITING DURING PREGNANCY: a Collection and Analysis of Cases, with Remarks on Treatment. 8vo, 6*s.*

THE DIAGNOSIS AND TREATMENT OF THE DISEASES OF WOMEN. Fourth Edition, in great part Re-written and much Enlarged, with 211 Engravings on Wood, of which 79 are new in this edition. 8vo, price 24*s.*

HOLMES. A SYSTEM OF SURGERY, Theoretical and Practical. Edited by TIMOTHY HOLMES, M.A.; and J. W. HULKE, F.R.S., Surgeon to the Middlesex Hospital. Third Edition, in Three Volumes, with Coloured Plates and numerous Illustrations. 3 Vols., royal 8vo, price £4 4*s.*

LADD.—*WORKS by GEORGE T. LADD, Professor of Philosophy in Yale University,*

ELEMENTS OF PHYSIOLOGICAL PSYCHOLOGY: A TREATISE OF THE ACTIVITIES AND NATURE OF THE MIND FROM THE PHYSICAL AND EXPERIMENTAL POINT OF VIEW. With 113 Illustrations. 8vo, price 21*s.*

OUTLINES OF PHYSIOLOGICAL PSYCHOLOGY. With numerous Illustrations. 8vo. 12*s.*

LITTLE. ON IN-KNEE DISTORTION (GENU VALGUM): Its Varieties and Treatment with and without Surgical Operation. By W. J. LITTLE, M.D., F.R.C.P.; Author of "The Deformities of the Human Frame," &c. Assisted by MUIRHEAD LITTLE, M.R.C.S., L.R.C.P. With 40 Woodcut Illustrations. 8vo, price 7*s.* 6*d.*

LIVEING.—*WORKS by ROBERT LIVEING, M.A. & M.D. Cantab., F.R.C.P. Lond., &c., Physician to the Department for Diseases of the Skin at the Middlesex Hospital, &c.*

HANDBOOK ON DISEASES OF THE SKIN. With especial reference to Diagnosis and Treatment. Fifth Edition, revised and enlarged. Fcap. 8vo, price 5*s.*

NOTES ON THE TREATMENT OF SKIN DISEASES. Fifth Edition. 18mo, price 3*s.*

ELEPHANTIASIS GRÆCORUM, OR TRUE LEPROSY; Being the Goulstonian Lectures for 1873. Cr. 8vo, 4*s.* 6*d.*

LONGMORE.—*WORKS by Surgeon-General Sir T. LONGMORE, C.B., F.R.C.S., Honorary Surgeon to H.M. Queen Victoria; Professor of Military Surgery in the Army Medical School.*

THE ILLUSTRATED OPTICAL MANUAL; OR, HANDBOOK OF INSTRUCTIONS FOR THE GUIDANCE OF SURGEONS IN TESTING QUALITY AND RANGE OF VISION, AND IN DISTINGUISHING AND DEALING WITH OPTICAL DEFECTS IN GENERAL. Illustrated by 74 Drawings and Diagrams by Inspector-General Dr. MACDONALD, R.N., F.R.S., C.B. Fourth Edition. 8vo, price 14*s.*

GUNSHOT INJURIES. Their History, Characteristic Features, Complications, and General Treatment; with Statistics concerning them as they are met with in Warfare. With 58 Illustrations. 8vo, price 31*s.* 6*d.*

MITCHELL. DISSOLUTION AND EVOLUTION AND THE SCIENCE OF MEDICINE: An Attempt to Co-ordinate the necessary Facts of Pathology and to establish the First Principles of Treatment. By C. PITFIELD MITCHELL, M.R.C.S. 8vo, price 16*s.*

MURCHISON.—*WORKS by CHARLES MURCHISON, M.D., LL.D., F.R.S., &c., Fellow of the Royal College of Physicians; late Physician and Lecturer on the Principles and Practice of Medicine, St. Thomas's Hospital.*

A TREATISE ON THE CONTINUED FEVERS OF GREAT BRITAIN. Third Edition, Edited by W. CAYLEY, M.D., F.R.C.P. With 6 Coloured Plates and Lithographs, 19 Diagrams and 20 Woodcut Illustrations. 8vo, price 25*s.*

CLINICAL LECTURES ON DISEASES OF THE LIVER, JAUNDICE, AND ABDOMINAL DROPSY; Including the Croonian Lectures on Functional Derangements of the Liver, delivered at the Royal College of Physicians in 1874. New Edition, Revised by T. LAUDER BRUNTON, M.D. 8vo, price 24*s.*

NEWMAN. ON THE DISEASES OF THE KIDNEY AMENABLE TO SURGICAL TREATMENT. Lectures to Practitioners. By DAVID NEWMAN, M.D., Surgeon to the Western Infirmary Out-Door Department; Pathologist and Lecturer on Pathology at the Glasgow Royal Infirmary; Examiner in Pathology in the University of Glasgow; Vice-President Glasgow Pathological and Clinical Society. 8vo, price 16*s.*

OWEN. A MANUAL OF ANATOMY FOR SENIOR STUDENTS. By EDMUND OWEN, M.B., F.R.S.C., Surgeon to St. Mary's Hospital, London, and co-Lecturer on Surgery, late Lecturer on Anatomy in its Medical School. With 210 Illustrations. Crown 8vo, price 12*s.* 6*d.*

PAGET.—*WORKS by Sir JAMES PAGET, Bart., F.R.S., D.C.L. Oxon., LL.D. Cantab., &c., Sergeant-Surgeon to the Queen, Surgeon to the Prince of Wales, Consulting Surgeon to St. Bartholomew's Hospital.*

LECTURES ON SURGICAL PATHOLOGY, Delivered at the Royal College of Surgeons of England Fourth Edition, re-edited by the AUTHOR and W. TURNER, M.B. 8vo, with 131 Woodcuts. price 21*s.*

CLINICAL LECTURES AND ESSAYS. Edited by F. HOWARD MARSH, Assistant-Surgeon to St. Bartholomew's Hospital. Second Edition, revised. 8vo, price 15*s.*

STUDIES OF OLD CASE-BOOKS. 8vo, 8*s.* 6*d.*

QUAIN. QUAIN'S (JONES) ELEMENTS OF ANATOMY. The Tenth Edition. Edited by EDWARD ALBERT SCHÄFER, F.R.S., Professor of Physiology and Histology in University College, London; and GEORGE DANCER THANE, Professor of Anatomy in University College, London. (In three volumes.)

VOL. I., PART I. EMBRYOLOGY. By Professor SCHÄFER. Illustrated by 200 Engravings, many of which are coloured. Royal 8vo, 9*s.* [*Ready.*

VOL. I., PART II. GENERAL ANATOMY OR HISTOLOGY. By Professor SCHÄFER. Illustrated by nearly 500 Engravings, many of which are coloured. Royal 8vo, 12*s.* 6*d.* [*Ready.*

VOL. II., PART I. OSTEOLOGY. By Professor THANE. Illustrated by 168 Engravings. Royal 8vo, 9*s.* [*Ready.*

QUAIN. A DICTIONARY OF MEDICINE; Including General Pathology, General Therapeutics, Hygiene, and the Diseases peculiar to Women and Children. By Various Writers. Edited by SIR RICHARD QUAIN, Bart., M.D., F.R.S., Physician Extraordinary to H.M. the Queen, Fellow of the Royal College of Physicians, Consulting Physician to the Hospital for Consumption, Brompton. Sixteenth Thousand; pp. 1,836, with 138 Illustrations engraved on wood. 1 Vol. medium 8vo, price 31*s.* 6*d.* cloth. To be had also in Two Volumes, price 34*s.* cloth.

RICHARDSON. THE ASCLEPIAD. A Book of Original Research in the Science, Art, and Literature of Medicine. By BENJAMIN WARD RICHARDSON, M.D., F.R.S. Published Quarterly, price 2*s.* 6*d.* Volumes for 1884, 1885, 1886, 1887, 1888 & 1889, 8vo, price 12*s.* 6*d.* each.

SALTER. DENTAL PATHOLOGY AND SURGERY. By S. JAMES A. SALTER, M.B., F.R.S., Examiner in Dental Surgery at the Royal College of Surgeons; Dental Surgeon to Guy's Hospital. With 133 Illustrations. 8vo, price 18*s.*

SMITH (H. F.). THE HANDBOOK FOR MIDWIVES. By HENRY FLY SMITH, B.A., M.B. Oxon., M.R.C.S. Second Edition, thoroughly revised. With 41 Woodcuts. Crown 8vo, price 5*s.*

STEEL.—*WORKS by JOHN HENRY STEEL, F.R.C.V.S., F.Z.S., A.V.D., Professor of Veterinary Science and Principal of Bombay Veterinary College.*

A TREATISE ON THE DISEASES OF THE DOG; being a Manual of Canine Pathology. Especially adapted for the use of Veterinary Practitioners and Students. 88 Illustrations. 8vo, 10*s.* 6*d.*

A TREATISE ON THE DISEASES OF THE OX; being a Manual of Bovine Pathology specially adapted for the use of Veterinary Practitioners and Students. 2 Plates and 117 Woodcuts. 8vo, 15*s.*

A TREATISE ON THE DISEASES OF THE SHEEP; being a Manual of Ovine Pathology for the use of Veterinary Practitioners and Students. With Coloured Plate, and 99 Woodcuts. 8vo, 12*s.*

"STONEHENGE." THE DOG IN HEALTH AND DISEASE. By "STONEHENGE." With 84 Wood Engravings. Square Crown 8vo, 7*s.* 6*d.*

WEST.—*WORKS by CHARLES WEST, M.D., &c., Founder of and formerly Physician to the Hospital for Sick Children.*

LECTURES ON THE DISEASES OF INFANCY AND CHILDHOOD. Seventh Edition, revised and enlarged. 8vo, 18*s.*

THE MOTHER'S MANUAL OF CHILDREN'S DISEASES. Fcp. 8vo, 2*s.* 6*d.*

WILKS AND MOXON. LECTURES ON PATHOLOGICAL ANATOMY. By SAMUEL WILKS, M.D., F.R.S., Consulting Physician to, and formerly Lecturer on Medicine and Pathology at, Guy's Hospital, and the late WALTER MOXON, M.D., F.R.C.P., Physician to, and some time Lecturer on Pathology at, Guy's Hospital. Third Edition, thoroughly Revised. By SAMUEL WILKS, M.D., LL.D., F.R.S. 8vo, price 18*s.*

WILLIAMS. PULMONARY CONSUMPTION: ITS ETIOLOGY, PATHOLOGY, AND TREATMENT. With an Analysis of 1,000 Cases to Exemplify its Duration and Modes of Arrest. By C. J. B. WILLIAMS, M.D., LL.D., F.R.S., F.R.C.P., Senior Consulting Physician to the Hospital for Consumption, Brompton; and CHARLES THEODORE WILLIAMS, M.A., M.D., Oxon. F.R.C.P., Senior Physician to the Hospital for Consumption, Brompton. Second Edition, Enlarged and Re-written by Dr. C. THEODORE WILLIAMS. With 4 Coloured Plates and 10 Woodcuts. 8vo, price 16*s.*

YOUATT.—*WORKS by WILLIAM YOUATT.*

THE HORSE. Revised and Enlarged by W. WATSON, M.R.C.V.S. Woodcuts. 8vo, 7*s.* 6*d.*

THE DOG. Revised and Enlarged. Woodcuts. 8vo, 6*s.*

General Scientific Works.

ARNOTT. THE ELEMENTS OF PHYSICS OR NATURAL PHILOSOPHY. By NEIL ARNOTT, M.D. Edited by A. BAIN, LL.D. and A. S. TAYLOR, M.D., F.R.S. Woodcuts. Crown 8vo, 12*s.* 6*d.*

BENNETT AND MURRAY. A HANDBOOK OF CRYPTOGAMIC BOTANY. By A. W. BENNETT, M.A., B.Sc., F.L.S., and GEORGE R. MILNE MURRAY, F.L.S. With 378 Illustrations. 8vo, price 16*s.*

CLERKE. THE SYSTEM OF THE STARS. By AGNES M. CLERKE, Author of "A History of Astronomy during the Nineteenth Century." With 6 Plates and Numerous Illustrations. 8vo, 21*s.*

CLODD. THE STORY OF CREATION. A Plain Account of Evolution. By EDWARD CLODD, Author of "The Childhood of the World," &c. With 77 Illustrations. Crown 8vo, 3*s.* 6*d.*

CROOKES. SELECT METHODS IN CHEMICAL ANALYSIS (chiefly Inorganic). By W. CROOKES, F.R.S., V.P.C.S., Editor of "The Chemical News." Second Edition, re-written and greatly enlarged. Illustrated with 37 Woodcuts. 8vo, price 24*s.*

CULLEY. A HANDBOOK OF PRACTICAL TELEGRAPHY. By R. S. CULLEY, M.I.C.E., late Engineer-in-Chief of Telegraphs to the Post Office. Eighth Edition, completely revised. With 135 Woodcuts and 17 Plates, 8vo, 16*s.*

DURRANT. LAWS AND DEFINITIONS CONNECTED WITH CHEMISTRY AND HEAT. With Explanatory Notes on Physical and Theoretical Chemistry, also special Tests and Examples for Practical Analysis. By R. G. DURRANT, M.A., F.C.S., Assistant-master at Marlborough College. 3*s.*

EARL. THE ELEMENTS OF LABORATORY WORK. A Course of Natural Science for Schools. By A. G. EARL, M.A., F.C.S., late Scholar of Christ College, Cambridge; Science Master at Tonbridge School. With 57 Diagrams and numerous Exercises and Questions. Crown 8vo, price 4*s.* 6*d.*

FORBES. A COURSE OF LECTURES ON ELECTRICITY. Delivered before the Society of Arts. By GEORGE FORBES, M.A., F.R.S. (L. & E.) With 17 Illustrations. Crown 8vo, 5*s.*

GALLOWAY. THE FUNDAMENTAL PRINCIPLES OF CHEMISTRY PRACTICALLY TAUGHT BY A NEW METHOD. By ROBERT GALLOWAY, M.R.I.A., F.C.S., Honorary Member of the Chemical Society of the Lehigh University, U.S. ; Author of "A Treatise on Fuel, Scientific and Practical," &c. Crown 8vo, 6*s.* 6*d.*

GANOT. ELEMENTARY TREATISE ON PHYSICS; Experimental and Applied, for the use of Colleges and Schools. Translated and edited from GANOT'S *Eléments de Physique* (with the Author's sanction) by E. ATKINSON, Ph.D., F.C.S., Professor of Experimental Science, Staff College, Sandhurst. Twelfth Edition, revised and enlarged, with 5 Coloured Plates and 923 Woodcuts. Large crown 8vo, price 15*s.*

NATURAL PHILOSOPHY FOR GENERAL READERS AND YOUNG PERSONS; Being a Course of Physics divested of Mathematical Formulæ, and expressed in the language of daily life. Translated from GANOT'S *Cours de Physique* (with the Author's sanction) by E. ATKINSON, Ph.D., F.C.S. Seventh Edition, carefully revised; with 37 pages of New Matter, 2 Coloured Plates, 3 New Maps, 569 Woodcuts, and an Appendix of Questions. Crown 8vo, price 7*s.* 6*d.*

GIBSON. A TEXT-BOOK OF ELEMENTARY BIOLOGY. By R. J. HARVEY GIBSON, M.A., F.R.S.E., Lecturer on Botany in University College, Liverpool. With 192 Illustrations. Crown 8vo, price 6*s.*

GOODEVE.—*WORKS by T. M. GOODEVE, M.A., Barrister-at-Law; Professor of Mechanics at the Normal School of Science and the Royal School of Mines.*

PRINCIPLES OF MECHANICS. New Edition, re-written and enlarged. With 253 Woodcuts and numerous Examples. Crown 8vo, 6*s.*

THE ELEMENTS OF MECHANISM. New Edition, re-written and enlarged. With 342 Woodcuts. Crown 8vo, 6*s.*

A MANUAL OF MECHANICS: an Elementary Text-Book for Students of Applied Mechanics. With 138 Illustrations and Diagrams, and 141 Examples taken from the Science Department Examination Papers, with Answers. Fcp. 8vo, 2*s.* 6*d.*

HELMHOLTZ.—*WORKS by HERMANN L. F. HELMHOLTZ, M.D., Professor of Physics in the University of Berlin.*

ON THE SENSATIONS OF TONE AS A PHYSIOLOGICAL BASIS FOR THE THEORY OF MUSIC. Second English Edition; with numerous additional Notes, and a new Additional Appendix, bringing down information to 1885, and specially adapted to the use of Musical Students. By ALEXANDER J. ELLIS, B.A., F.R.S., F.S.A., &c., formerly Scholar of Trinity College, Cambridge. With 68 Figures engraved on Wood, and 42 Passages in Musical Notes. Royal 8vo, price 28*s.*

POPULAR LECTURES ON SCIENTIFIC SUBJECTS. With 68 Woodcuts. 2 Vols. crown 8vo, 15*s.*, or separately, 7*s.* 6*d.* each.

HERSCHEL. OUTLINES OF ASTRONOMY. By Sir JOHN F. W. HERSCHEL, Bart., K.H., &c., Member of the Institute of France. Twelfth Edition, with 9 Plates, and numerous Diagrams. Square crown 8vo, price 12*s.*

HUDSON AND GOSSE. THE ROTIFERA OR 'WHEEL ANIMALCULES.' By C. T. HUDSON, LL.D., and P. H. GOSSE, F.R.S. With 30 Coloured and 4 Uncoloured Plates. In 6 Parts. 4to, price 10*s.* 6*d.* each; Supplement, 12*s.* 6*d.* Complete in Two Volumes, with Supplement, 4to, £4 4*s.*

*** The Plates in the Supplement contain figures of almost all the Foreign Species, as well as of the British Species, that have been discovered since the original publication of Vols. I. and II.

IRVING. PHYSICAL AND CHEMICAL STUDIES IN ROCK-METAMORPHISM, based on the Thesis written for the D.Sc. Degree in the University of London, 1888. By the Rev. A. IRVING, D.Sc. Lond., Senior Science Master at Wellington College. 8vo, 5*s.*

JORDAN.—*WORKS by WILLIAM LEIGHTON JORDAN, F.R.G.S.*

THE OCEAN: A Treatise on Ocean Currents and Tides and their Causes. 8vo, 21*s.*

THE STANDARD OF VALUE. 8vo, 6*s.*

KOLBE. A SHORT TEXT-BOOK OF INORGANIC CHEMISTRY. By Dr. HERMANN KOLBE, Professor of Chemistry in the University of Leipzig. Translated and Edited by T. S. HUMPIDGE, Ph.D., B.Sc. (Lond.), Professor of Chemistry and Physics in the University College of Wales, Aberystwyth. With a Coloured Table of Spectra and 66 Woodcuts. Second Edition. Crown 8vo, price 7*s.* 6*d.*

LARDEN. ELECTRICITY FOR PUBLIC SCHOOLS AND COLLEGES. With numerous Questions and Examples with Answers, and 214 Illustrations and Diagrams. By W. LARDEN, M.A. Crown 8vo, 6*s*.

LINDLEY AND MOORE. THE TREASURY OF BOTANY, OR POPULAR DICTIONARY OF THE VEGETABLE KINGDOM: with which is incorporated a Glossary of Botanical Terms. Edited by J. LINDLEY, M.D., F.R.S., and T. MOORE, F.L.S. With 20 Steel Plates, and numerous Woodcuts. 2 Parts, fcp. 8vo, price 12*s*.

LOUDON. AN ENCYCLOPÆDIA OF PLANTS. By J. C. LOUDON. Comprising the Specific Character, Description, Culture, History, Application in the Arts, and every other desirable particular respecting all the plants indigenous to, cultivated in, or introduced into, Britain. Corrected by Mrs. LOUDON. 8vo, with above 12,000 Woodcuts, price 42*s*.

MARTIN. NAVIGATION AND NAUTICAL ASTRONOMY. Compiled by Staff-Commander W. R. MARTIN, R.N., Instructor in Surveying, Navigation, and Compass Adjustment; Lecturer on Meteorology at the Royal Naval College, Greenwich. Sanctioned for use in the Royal Navy by the Lords Commissioners of the Admiralty. Royal 8vo, 18*s*.

MENDELÉEFF. THE PRINCIPLES OF CHEMISTRY. By D. MENDELÉEFF, Professor of Chemistry in the University of St. Petersburg. Translated by GEORGE KAMENSKY, A.R.S.M. of the Imperial Mint, St. Petersburg, and Edited by A. J. GREENAWAY, F.I.C., Sub-Editor of the Journal of the Chemical Society. [*In preparation.*

MILLER.—*WORKS by WILLIAM ALLEN MILLER, M.D., D.C.L., LL.D. late Professor of Chemistry in King's College, London.*

THE ELEMENTS OF CHEMISTRY, Theoretical and Practical.

PART I. CHEMICAL PHYSICS. Sixth Edition, revised by HERBERT McLEOD, F.C.S. With 274 Woodcuts. 8vo, price 16*s*.

PART II. INORGANIC CHEMISTRY. Sixth Edition, revised throughout, with Additions by C. E. GROVES, Fellow of the Chemical Societies of London, Paris, and Berlin. With 376 Woodcuts. 8vo, price 24*s*.

PART III. ORGANIC CHEMISTRY, or the Chemistry of Carbon Compounds. *Hydrocarbons, Alcohols, Ethers, Aldehides and Paraffinoid Acids.* Fifth Edition, revised and in great part re-written, by H. E. ARMSTRONG, F.R.S., and C. E. GROVES, F.C.S. 8vo, price 31*s*. 6*d*.

MITCHELL. MANUAL OF PRACTICAL ASSAYING. By JOHN MITCHELL, F.C.S. Sixth Edition. Edited by W. CROOKES, F.R.S. With 201 Woodcuts. 8vo, price 31*s.* 6*d.*

MORGAN. ANIMAL BIOLOGY. An Elementary Text Book. By C. LLOYD MORGAN, Professor of Animal Biology and Geology in University College, Bristol. With numerous Illustrations. Crown 8vo, 8*s.* 6*d.*

ODLING. A COURSE OF PRACTICAL CHEMISTRY, Arranged for the use of Medical Students, with express reference to the Three Months' Summer Practice. By WILLIAM ODLING, M.A., F.R.S. Fifth Edition, with 71 Woodcuts. Crown 8vo, price 6*s.*

OLIVER. ASTRONOMY FOR AMATEURS: A PRACTICAL MANUAL OF TELESCOPIC RESEARCH IN ALL LATITUDES ADAPTED TO THE POWERS OF MODERATE INSTRUMENTS. Edited by JOHN A. WESTWOOD OLIVER, with the assistance of T. W. BACKHOUSE, F.R.A.S.; S. W. BURNHAM, M.A., F.R.A.S.; J. RAND CAPRON, F.R.A.S.; W. F. DENNING, F.R.A.S.; T. GWYN ELGER, F.R.A.S.; W. S. FRANKS, F.R.A.S.; J. E. GORE, M.R.I.A., F.R.A.S.; SIR HOWARD GRUBB, F.R.S., F.R.A.S.; E. W. MAUNDER, F.R.A.S.; and others. Illustrated. Crown 8vo, 7*s.* 6*d.*

PAYEN. INDUSTRIAL CHEMISTRY; A Manual for use in Technical Colleges or Schools, also for Manufacturers and others, based on a Translation of Stohmann and Engler's German Edition of PAYEN'S *Précis de Chimie Industrielle.* Edited and supplemented with Chapters on the Chemistry of the Metals, &c., by B. H. PAUL, Ph.D. With 698 Woodcuts. Medium 8vo, price 42*s.*

REYNOLDS. EXPERIMENTAL CHEMISTRY for Junior Students. By J. EMERSON REYNOLDS, M.D., F.R.S., Professor of Chemistry, Univ. of Dublin. Fcp. 8vo, with numerous Woodcuts.

PART I.—*Introductory*, price 1*s.* 6*d.*

PART II.—*Non-Metals*, with an Appendix on Systematic Testing for Acids, price 2*s.* 6*d.*

PART III.—*Metals and Allied Bodies*, price 3*s.* 6*d.*

PART IV.—*Chemistry of Carbon Compounds*, price 4*s.*

PROCTOR.—*WORKS by RICHARD A. PROCTOR.*

LIGHT SCIENCE FOR LEISURE HOURS; Familiar Essays on Scientific Subjects, Natural Phenomena, &c. 3 Vols. crown 8vo, 5*s.* each.

THE ORBS AROUND US; a Series of Essays on the Moon and Planets, Meteors, and Comets. With Chart and Diagrams, crown 8vo, 5*s.*

OTHER WORLDS THAN OURS; The Plurality of Worlds Studied under the Light of Recent Scientific Researches. With 14 Illustrations, crown 8vo, 5*s.*

THE MOON; her Motions, Aspects, Scenery, and Physical Condition. With Plates, Charts, Woodcuts, and Lunar Photographs, crown 8vo, 5*s.*

UNIVERSE OF STARS; Presenting Researches into and New Views respecting the Constitution of the Heavens. With 22 Charts and 22 Diagrams, 8vo. 10*s.* 6*d.*

LARGER STAR ATLAS for the Library, in 12 Circular Maps, with Introduction and 2 Index Pages. Folio, 15*s.*, or Maps only, 12*s.* 6*d.*

NEW STAR ATLAS for the Library, the School, and the Observatory, in 12 Circular Maps (with 2 Index Plates). Crown 8vo, 5*s.*

THE STUDENT'S ATLAS. In 12 Circular Maps on a Uniform Projection and 1 Scale, with 2 Index Maps. Intended as a *vade-mecum* for the Student of History, Travel, Geography, Geology, and Political Economy. With a letter-press Introduction illustrated by several cuts. 5*s.*

OLD AND NEW ASTRONOMY. In 12 Parts. Price 2*s.* 6*d.* each; supplementary section, 1*s.* (in course of publication); complete, 36*s.* cloth. [*Nearly ready.*

STUDIES OF VENUS-TRANSITS; an Investigation of the Circumstances of the Transits of Venus in 1874 and 1882. With 7 Diagrams and 10 Plates. 8vo, 5*s.*

ELEMENTARY PHYSICAL GEOGRAPHY. With 33 Maps and Woodcuts. Fcp. 8vo, 1*s.* 6*d.*

LESSONS IN ELEMENTARY ASTRONOMY; with Hints for Young Telescopists. With 47 Woodcuts. Fcp. 8vo, 1*s.* 6*d.*

FIRST STEPS IN GEOMETRY: a Series of Hints for the Solution of Geometrical Problems; with Notes on Euclid, useful Working Propositions, and many Examples. Fcp. 8vo, 3*s.* 6*d.*

EASY LESSONS IN THE DIFFERENTIAL CALCULUS: indicating from the Outset the Utility of the Processes called Differentiation and Integration. Fcp. 8vo, 2*s.* 6*d.*

THE STARS IN THEIR SEASONS. An Easy Guide to a Knowledge of the Star Groups, in 12 Large Maps. Imperial 8vo, 5*s.*

STAR PRIMER. Showing the Starry Sky Week by Week, in 24 Hourly Maps. Crown 4to, 2*s.* 6*d.*

THE SEASONS PICTURED IN 48 SUN VIEWS OF THE EARTH, and 24 Zodiacal Maps, &c. Demy 4to, 5*s.*

ROUGH WAYS MADE SMOOTH. Familiar Essays on Scientific Subjects. Crown 8vo, 5*s.*

HOW TO PLAY WHIST: WITH THE LAWS AND ETIQUETTE OF WHIST. Crown 8vo, 3*s.* 6*d.*

HOME WHIST: an Easy Guide to Correct Play. 16mo, 1*s.*

[*Continued.*

PROCTOR.—*WORKS by RICHARD A. PROCTOR—continued.*

OUR PLACE AMONG INFINITIES. A Series of Essays contrasting our Little Abode in Space and Time with the Infinities around us. Crown 8vo, 5*s*.

STRENGTH AND HAPPINESS. Crown 8vo, 5*s*.

STRENGTH: How to get Strong and keep Strong, with Chapters on Rowing and Swimming, Fat, Age, and the Waist. With 9 Illustrations. Crown 8vo, 2*s*.

THE EXPANSE OF HEAVEN. Essays on the Wonders of the Firmament. Crown 8vo, 5*s*.

THE GREAT PYRAMID, OBSERVATORY, TOMB, AND TEMPLE. With Illustrations. Crown 8vo, 5*s*.

PLEASANT WAYS IN SCIENCE. Crown 8vo, 5*s*.

MYTHS AND MARVELS OF ASTRONOMY. Crown 8vo, 5*s*.

CHANCE AND LUCK; a Discussion of the Laws of Luck, Coincidences, Wagers, Lotteries, and the Fallacies of Gambling, &c. Crown 8vo, 2*s*. boards, 2*s*. 6*d*. cloth.

NATURE STUDIES. By GRANT ALLEN, A. WILSON, T. FOSTER, E. CLODD, and R. A. PROCTOR. Crown 8vo, 5*s*.

LEISURE READINGS. By E. CLODD, A. WILSON, T. FOSTER, A. C. RUNYARD, and R. A. PROCTOR. Crown 8vo, 5*s*.

SCOTT. WEATHER CHARTS AND STORM WARNINGS. By ROBERT H. SCOTT, M.A., F.R.S. With numerous Illustrations. Crown 8vo, 6*s*.

SLINGO AND BROOKER. ELECTRICAL ENGINEERING FOR ELECTRIC LIGHT ARTISANS AND STUDENTS. (Embracing those branches prescribed in the Syllabus issued by the City and Guilds Technical Institute.) By W. SLINGO, Principal of the Telegraphists' School of Science, &c., &c., and A. BROOKER, Instructor on Electrical Engineering at the Telegraphists' School of Science. With 307 Illustrations. Crown 8vo, price 10*s*. 6*d*.

SMITH. GRAPHICS; OR, THE ART OF CALCULATION BY DRAWING LINES, applied to Mathematics, Theoretical Mechanics and Engineering, including the Kinetics and Dynamics of Machinery, and the Statics of Machines, Bridges, Roofs, and other Engineering Structures. By ROBERT H. SMITH, Professor of Civil and Mechanical Engineering, Mason Science College, Birmingham.

PART I. Text, with separate Atlas of Plates—Arithmetic, Algebra, Trigonometry, Vector, and Locor Addition, Machine Kinematics, and Statics of Flat and Solid Structures. 8vo, 15*s*.

THORPE. A DICTIONARY OF APPLIED CHEMISTRY. By T. E. THORPE, B.Sc. (Vict.), Ph.D., F.R.S., Treas. C.S., Professor of Chemistry in the Royal College of Science, London. Assisted by Eminent Contributors. 3 vols., £2 2*s*. each. [*Vols. I. and II. now ready.*

TYNDALL.—*WORKS by JOHN TYNDALL, F.R.S., &c.*

FRAGMENTS OF SCIENCE. 2 Vols. Crown 8vo, 16*s.*

HEAT A MODE OF MOTION. Crown 8vo, 12*s.*

SOUND. With 204 Woodcuts. Crown 8vo, 10*s.* 6*d.*

RESEARCHES ON DIAMAGNETISM AND MAGNE-CRYSTALLIC ACTION, including the question of Diamagnetic Polarity. Crown 8vo, 12*s.*

ESSAYS ON THE FLOATING-MATTER OF THE AIR in relation to Putrefaction and Infection. With 24 Woodcuts. Crown 8vo, 7*s.* 6*d.*

LECTURES ON LIGHT, delivered in America in 1872 and 1873. With 57 Diagrams. Crown 8vo, 5*s.*

LESSONS IN ELECTRICITY AT THE ROYAL INSTITUTION, 1875-76. With 58 Woodcuts. Crown 8vo, 2*s.* 6*d.*

NOTES OF A COURSE OF SEVEN LECTURES ON ELECTRICAL PHENOMENA AND THEORIES, delivered at the Royal Institution. Crown 8vo, 1*s.* sewed, 1*s.* 6*d.* cloth.

NOTES OF A COURSE OF NINE LECTURES ON LIGHT, delivered at the Royal Institution. Crown 8vo, 1*s.* sewed, 1*s.* 6*d.* cloth.

FARADAY AS A DISCOVERER. Fcp. 8vo, 3*s.* 6*d.*

WATTS' DICTIONARY OF CHEMISTRY. Revised and entirely Re-written by H. FORSTER MORLEY, M.A., D.Sc., Fellow of, and lately Assistant-Professor of Chemistry in, University College, London; and M. M. PATTISON MUIR, M.A., F.R.S.E., Fellow, and Prælector in Chemistry, of Gonville and Caius College, Cambridge. Assisted by Eminent Contributors. To be Published in 4 Vols. 8vo. Vols. I. II. 42*s.* each. [*Now ready.*

WEBB. CELESTIAL OBJECTS FOR COMMON TELESCOPES. By the Rev. T. W. Webb, M.A. Fourth Edition, adapted to the Present State of Sidereal Science; Map, Plate, Woodcuts. Crown 8vo, price 9*s.*

WILLIAMS. MANUAL OF TELEGRAPHY. By W. WILLIAMS, Superintending Indian Government Telegraphs. With 93 Woodcuts. 8vo, 10*s.* 6*d.*

WRIGHT. OPTICAL PROJECTION: A Treatise on the Use of the Lantern in Exhibition and Scientific Demonstration. By LEWIS WRIGHT, Author of "Light: a Course of Experimental Optics." With 232 Illustrations. Crown 8vo, 6*s.*

TEXT-BOOKS OF SCIENCE.

PHOTOGRAPHY. By Captain W. De Wiveleslie Abney, C.B., F.R.S. With 105 Woodcuts. Price 3*s.* 6*d.*

THE STRENGTH OF MATERIALS AND STRUCTURES: the Strength of Materials as depending on their quality and as ascertained by Testing Apparatus; the Strength of Structures, as depending on their form and arrangement, and on the materials of which they are composed. By Sir J. Anderson, C.E., &c. With 66 Woodcuts. Price 3*s.* 6*d.*

INTRODUCTION TO THE STUDY OF ORGANIC CHEMISTRY; the CHEMISTRY of CARBON and its COMPOUNDS. By Henry E. Armstrong, Ph.D., F.R.S. With 8 Woodcuts. Price 3*s.* 6*d.*

ELEMENTS OF ASTRONOMY. By Sir R. S. Ball, LL.D., F.R.S., Royal Astronomer of Ireland. With 136 Woodcuts. Price 6*s.*

RAILWAY APPLIANCES. A Description of Details of Railway Construction subsequent to the completion of Earthworks and Structures, including a short Notice of Railway Rolling Stock. By John Wolfe Barry, M.I.C.E. With 218 Woodcuts. Price 4*s.* 6*d.*

SYSTEMATIC MINERALOGY. By Hilary Bauerman, F.G.S. With 373 Woodcuts. Price 6*s.*

DESCRIPTIVE MINERALOGY. By Hilary Bauerman, F.G.S., &c. With 236 Woodcuts. Price 6*s.*

METALS, THEIR PROPERTIES AND TREATMENT. By C. L. Bloxam and A. K. Huntington. With 130 Woodcuts. Price 5*s.*

PRACTICAL PHYSICS. By R. T. Glazebrook, M.A., F.R.S., and W. N. Shaw, M.A. With 80 Woodcuts. Price 6*s.*

PHYSICAL OPTICS. By R. T. Glazebrook, M.A., F.R.S. With 183 Woodcuts. Price 6*s.*

THE ART OF ELECTRO-METALLURGY, including all known processes of Electro-Deposition. By G. Gore, LL.D., F.R.S. With 56 Woodcuts. Price 6*s.*

ALGEBRA AND TRIGONOMETRY. By William Nathaniel Griffin, B.D. Price 3*s.* 6*d.* NOTES ON, with SOLUTIONS of QUESTIONS. Price 3*s.* 6*d.*

THE STEAM-ENGINE. By George C. V. Holmes. 212 Woodcuts. Price 6*s.*

ELECTRICITY AND MAGNETISM. By Fleeming Jenkin, F.R.SS. L. & E. With 177 Woodcuts. Price 3*s.* 6*d.*

THEORY OF HEAT. By J. Clerk Maxwell, M.A., LL.D. Edin., F.R.SS. L. & E. With 41 Woodcuts. Price 3*s.* 6*d.*

TECHNICAL ARITHMETIC AND MENSURATION. By Charles W. Merrifield, F.R.S. Price 3*s.* 6*d.* KEY Price 3*s.* 6*d.*

INTRODUCTION TO THE STUDY OF INORGANIC CHEMISTRY. By William Allen Miller, M.D., LL.D., F.R.S. With 72 Woodcuts. Price 3*s.* 6*d.*

TELEGRAPHY. By W. H. Preece, F.R.S., M.I.C.E., and J. Sivewright, M.A., C. M. G. With 245 Woodcuts. Price 6*s.*

THE STUDY OF ROCKS, AN ELEMENTARY TEXT-BOOK OF PETROLOGY. By Frank Rutley, F.G.S. With 6 Plates and 88 Woodcuts. Price 4*s.* 6*d.*

WORKSHOP APPLIANCES, including Descriptions of some of the Gauging and Measuring Instruments — Hand-Cutting Tools, Lathes, Drilling, Planing, and other Machine Tools used by Engineers. By C. P. B. Shelley, M.I.C.E. With 291 Woodcuts. Price 4*s.* 6*d.*

STRUCTURAL AND PHYSIOLOGICAL BOTANY. By Dr. Otto Wilhelm Thomé and A. W. Bennett, M.A., B.Sc., F.L.S. With 600 Woodcuts and a Coloured Map. Price 6*s.*

QUANTITATIVE CHEMICAL ANALYSIS. By T. E. Thorpe, F.R.S., Ph.D. With 88 Woodcuts. Price 4*s.* 6*d.*

QUALITATIVE ANALYSIS AND LABORATORY PRACTICE. By T. E. Thorpe, Ph. D., F.R.S., and M. M. Pattison Muir, M.A. and F.R.S.E. With Plate of Spectra and 57 Woodcuts. Price 3*s.* 6*d.*

INTRODUCTION TO THE STUDY OF CHEMICAL PHILOSOPHY; THE PRINCIPLES OF THEORETICAL AND SYSTEMATICAL CHEMISTRY. By William A. Tilden, D.Sc. London, F.R.S. With 5 Woodcuts. With or without Answers to Problems. Price 4*s.* 6*d.*

THE ELEMENTS OF MACHINE DESIGN. By W. Cawthorne Unwin, F.R.S. Part I., General Principles, Fastenings, and Transmissive Machinery. With 304 Diagrams and Illustrations, price 6*s.* Part II., chiefly on Engine details, with 174 Illustrations. Price 4*s.* 6*d.*

PRELIMINARY SURVEY. By Theodore Graham Gribble, Civil Engineer. Including Elementary Astronomy, Route Surveying, Tacheometry, Curve-ranging, Graphic Mensuration. With 130 Illustrations. Price 6*s.*

PLANE AND SOLID GEOMETRY. By H. W. Watson, M.A. Price 3*s.* 6*d.*

6000.5.91. BRADBURY, AGNEW, & CO. LIMD., PRINTERS, WHITEFRIARS.